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Office of Conservation and Solar Energy

Residential Conservation Service Program

DEPARTMENT OF ENERGY

Office of Conservation and Solar Energy

10 CFR Part 456

[Docket No. CSA-RM-79-101]

Residential Conservation Service Program

AGENCY: Department of Energy.

ACTION: Interim final rule.

SUMMARY: The Department of Energy (DOE) is implementing the Residential Conservation Service (RCS) Program pursuant to Title II, Part 1 of the National Energy Conservation Policy Act (NECPA) (Public Law 95-619, 92 Stat. 3206 *et seq.*) and amended by the Energy Security Act (ESA) (Public Law 96-294, 94 Stat. 611 *et seq.*). The purpose of the program is to encourage the installation of energy conservation measures and renewable resource measures, in existing houses by residential customers of larger gas and electric utilities and home heating suppliers.

On November 7, 1979, DOE issued a Final Rule for the RCS program (44 FR 64602). Included in the Final Rule were several reserved sections.

A Proposed Rule which filled in these reserved sections and proposed additional sections was published on December 21, 1979, (44 FR 75956); two of these reserved sections are finalized here. References to "the Interim Final Rule" will refer to the rule published today unless otherwise specified.

This Interim Final Rule establishes interim material standards and installation standards for urea-formaldehyde (U-F) foam insulation.

EFFECTIVE DATE: Sections 456.810 and 456.909 shall be effective on an interim basis on February 24, 1981.

ADDRESS: All reports in this Interim Final Rule are available for inspection in the Department of Energy Reading Room, Room 5B-180, Forrestal Building, 1000 Independence Avenue, S.W., Washington, D.C., between the hours of 8:00 a.m. and 4:30 p.m., Monday through Friday.

FOR FURTHER INFORMATION CONTACT:

James R. Tanck, Chief, Building Applications and Incentives Branch, Department of Energy, Room GH-068, 1000 Independence Avenue, S.W., Washington, D.C. 20585 (202) 252-9161

Susan Caplan, Office of General Counsel, Department of Energy, Room 1E-254, 1000 Independence Avenue, S.W., Washington, D.C. 20585 (202) 252-9513

SUPPLEMENTARY INFORMATION:

I. Introduction.
II. Standards.
III. Regulatory Analysis and Urban Impact Assessment.
IV. Environmental Impact Statement.
V. Record of Decision.
VI. Consultation with Other Federal Agencies.
VII. Contractor Contributions to the Rulemaking.

I. Introduction

The Department of Energy (DOE) is amending Part 456 of Chapter II of Title 10 CFR to complete the rulemaking requirements for Title II, Part 1 of the National Conservation Policy Act (NECPA) (Public Law 95-619). Several areas in the Final Rule established November 7, 1979, (44 FR 64602) were reserved pending further study and investigation. These reserved sections were proposed December 13, 1979, (44 FR 75956, December 21, 1979), and two are finalized here. Included herein are interim final standards for urea-formaldehyde (U-F) foam insulation.

II. Standards

A. Background

NECPA requires the Secretary to develop material and installation standards necessary to ensure general safety and effectiveness of the installed material. Included herein is an interim final material standard for U-F foam insulation and an interim final installation standard for U-F foam insulation.

B. Material Standard for Urea-Formaldehyde (U-F) Foam Insulation

Background

Considerable controversy exists regarding whether or not DOE should promulgate standards for U-F foam. More people submitted comments on U-F foam insulation (approximately 80) than on any other section of the December 21, 1979, Proposed Rule. Many contractors and manufacturers recommended development of a standard while several Federal agencies stated that development of a standard now is premature. Specifically:

- The Consumer Product Safety Commission (CPSC) strongly recommended that DOE not issue a standard. Their concerns were as follows:

(a) Absence of knowledge regarding tolerable human reaction level to formaldehyde;

(b) Lack of conclusive evidence of the performance of U-F foam under varying conditions;

(c) Uncertainty that DOE will address off-gassing problems;

(d) Potential carcinogenic effects.

- The Environmental Protection Agency (EPA) suggested that DOE not issue a standard because of:

(a) Potential carcinogenic effects;

(b) Degradation of U-F foam due to thermal and humidity cycling which cannot be controlled;

(c) The existence of adequate substitutes for U-F foam.

- The Federal Trade Commission (FTC) presented "staff concerns" which, although not necessarily the views of the Commission, included:

(a) Possible health risks from U-F foam and uncertainties about insulation effectiveness;

(b) Inclusion of U-F foam could be mistakenly perceived as Federal assurance regarding safety and effectiveness.

In addition, four national organizations and one State energy office were also opposed to issuance of a U-F foam standard. Several of these stated that it was the responsiblility of CPSC to develop a standard or to make a determination on the safety of the product.

On the other hand, the National Bureau of Standards (NBS) stated that "As long as U-F foam continues to be installed, standards should be available. Although the existence of standards in themselves cannot ensure effectiveness and safety, they can contribute to greater effectiveness and safety." This recommendation was made providing that specific additional programmatic safeguards were incorporated in the RCS rule. Numerous manufacturers and installers of U-F foam and one utility strongly recommended that DOE issue U-F foam standards.

DOE agrees with the several commenters who asserted that it is the responsibility of CPSC to take action to reduce or eliminate risk or injury associated with consumer products such as insulation. However, the CPSC is presently awaiting the results of two studies on the subject. The first study includes a panel of scientists from the Federal Government assembled by CPSC to evaluate the risk to humans of exposure to formaldehyde. The scientists will consider information relating to chronic human experience animal carcinogenicity, mutagenicity, and the effects of formaldehyde on teratology and reproduction. The panel hopes to complete a preliminary report by September 1980. The second study is being conducted by the Franklin Research Institute for CPSC to examine the chemical characteristics of various types of U-F foam insulation. Although

a draft of this study is complete, it is not expected to be finalized until September or October.

Because of these studies and for other reasons discussed below, we are delaying the effective date of this rule for 150 days after publication when preliminary results of the studies will be complete. At that time the standard would in the absence of other action by DOE and CPSC become effective on an interim basis. During this period, as discussed below, DOE will also propose amendments to the interim standard. Moreover, if during this period of time significant new information arises, DOE will be able to take whatever, action is appropriate, including if necessary, banning U–F foam from the RCS program. Obviously, DOE will conform its regulations with any legal action taken by the CPSC with respect to U–F foam. The interim nature of the U–F foam standard is recognition that further research is needed. Specific areas where additional information is needed are discussed later.

A further consideration in promulgating this rule on an interim basis is DOE's conclusion that there is insufficient information to respond fully to the questions postulated in the preamble of the Proposed Rule concerning the safety issues associated with U–F foam insulation (44 FR 75960, December 21, 1979). In response to the question of whether the standards adequately address off-gassing, DOE believes that these standards meet some of the problems of off-gassing and provide a minimum level of general safety and effectiveness, which would not be assured by any Federal regulation in the absence of these standards. For further discussion see section B under General Technical Issues. We are unable to respond to the second question on tolerable levels of formaldehyde since there is no available data establishing an acceptable level of formaldehyde exposure. For further discussion see section A under General Technical Issues. The third question dealt with whether the RCS standards are practical, are capable of being followed and are likely to be followed by installers. DOE is confident that these standards are indeed practical and capable of being followed and that the manufacturers' certification responsibility gives added assurances that the standards will be met. See section C under General Technical Issues for further discussion.

In addition, CPSC made several suggestions for improving the interim U–F foam standards after the close of comment period, February 19, 1980. Because these suggestions have the potential to increase the effectiveness of the standards, DOE intends to propose them for comment shortly. It is DOE's intent to adopt any of these proposals supported by the record so that they may become effective at the same time as the interim final standard adopted here. The proposed provisions will include:

- Limitation of methylol content in resin—current limitations on only formaldehyde in the resin may be counterproductive because this may reduce durability of the foam. Additives, including methylol, are being used to replace some percentage of the formaldehyde. After installation certain temperature and humidity conditions may cause a chemical reaction which may be transported as a vapor through the wall cavity. DOE will, therefore, propose a limitation on the combined contents of formaldehyde and methylol.
- Test procedure for determining formaldehyde content of fresh foam—in addition to measuring the formaldehyde content immediately after foaming, DOE will also propose testing at about 3 weeks and again at about 3 months. This should give a more accurate indication of not only the free formaldehyde which is present shortly after foaming, but also any hydrolyzable formaldehyde which may have formed later.
- Testing by a NVLAP accredited laboratory—DOE will request that the Department of Commerce incorporate the U–F foam test procedures into the National Voluntary Laboratory Accreditation Program (NVLAP). DOE will then propose that all U–F foam testing be done at an accredited laboratory once accredited laboratories exist.
- C–13 NMR testing—DOE will propose that each manufacturer submit samples from each batch of chemicals for carbon–13 Nuclear Magnetic Resins testing. It is anticipated that testing expense is low ($.50–$2.00/sample) and that there is sufficient laboratory capability to accommodate this requirement. C–13 will determine the chemical composition of U–F foam materials and verify that this composition does not change from batch to batch.
- Equipment calibration—DOE will propose criteria for calibrating equipment to be done semi-annually.
- Recirculation of chemicals during foaming—DOE will propose that resins and foaming agents be continuously agitated and recirculated to maintain uniformity of components. Equipment which continuously recirculates the resin and foaming agent will help ensure that no chemical separation occurs and that no temperature gradient builds up.
- Requirement for bottled gas—because oil contamination from air compressors can cause foaming problems, DOE will propose that bottled gas replace air compressors.
- Equipment requirement for air pressure monitoring—DOE will propose that only equipment which responds by shutdown to a drop in air pressure or to a 20 percent change in component ratios be used. DOE will also propose that shutdown occur within 15 seconds rather than 5 minutes as is required in the interim standards.

DOE defines an interim final standard as one which is temporary, pending additional information. Although all standards are continually being reevaluated, issuance of an interim final standard is recognition that further research is needed in certain areas. Specific areas where additional information is needed are discussed later.

Although DOE has concerns about alleged health and safety hazards associated with the material, there is insufficient data at the present time to exclude U–F foam from the RCS program. Specifically, DOE considered the following:

(a) The National Energy Conservation Policy Act (NECPA) requires DOE to issue standards which ensure "*general* safety and effectiveness." "General" does not imply complete safety. The conference report of NECPA states "The conferees intend that activities of the Secretary with respect to standards for general safety and effectiveness of residential energy conservation measures be limited to those necessary to establish a *minimum* level for general safety and effectiveness of any such measure." The issue then is whether DOE's U–F foam standards ensure a minimum level of general safety. Based upon a thorough review of the evidence submitted in the course of the rulemaking, DOE believes that the interim standards do assure a minimum level for general safety and effectiveness of U–F foam. Certain evidence submitted during the rulemaking, however, including evidence submitted by CPSC, if confirmed by further analysis or additional data, could require a reassessment of this conclusion. Nevertheless, DOE is confident that the interim standard provides safeguards that would not exist in the absence of any Federal standard. Reasons for this are:

- The standards greatly limit areas of application. They do not permit, for instance, application of U–F foam in

ceilings, in knee walls, below grade, in mobile homes, or in areas with an impermeable exterior facing. Although reporting format in the CPSC complaint cases is inconsistent, it appears that a substantial portion of complainants had U–F foam installed in one of these areas.

• The standards require suppliers to take responsibility for the use of their product by training, certifying, and inspecting installers who use their product. Specific criteria are required for inclusion in the training program.

• The standards require suppliers to recommend and test equipment used by their installers and they require installers to use the recommended equipment. Equipment also must meet specific criteria.

• The standards limit the amount of free formaldehyde in the resin and the fresh foam. Although this by itself provides no guarantee that off-gassing of formaldehyde will not occur, it does reduce the potential for initial off-gassing.

(b) There is insufficient technical data at this time to exclude the material from the RCS program. Specifically:

• Although the Chemical Industry Institute of Toxicology (CIIT) is conducting studies on the carcinogenic effects of formaldehyde, no relationship has been established between urea-formaldehyde and carcinogenic effects on humans. (See Progress Report on "Formaldehyde Toxicity Study," CIIT, P.O. Box 12137, Research Triangle Park, NC 27709.) When rats, mice and monkeys were exposed to 15 ppm of urea-formaldehyde 6 hours per day, 5 days a week (tolerances established by several European countries for indoor air levels for humans are considered to be between 0.1–0.4 ppm), only rats exhibited cancerous nodules. Laboratory animals, when exposed to lower levels (0.2–1.0 ppm) have to date exhibited no carcinogenic effects.

• No one in the United States has been able to establish an acceptable formaldehyde tolerance level for humans. The National Academy of Sciences (NAS), under contract to CPSC, attempted to establish a level and was unable to do so. (See "Formaldehyde—An Assessment of Its Health Effects" prepared by NAS, March 1980 for CPSC.) They concluded that there is no population threshold for the irritant effects of formaldehyde in humans. Information from controlled human studies and complaint-related investigations suggests that even at extremely low air borne concentrations, a proportion of the population will respond with some irritation. NAS recommended that formaldehyde be kept at the lowest practical concentration in indoor residential air. Without a specific tolerance level, however, it is difficult to determine what constitutes an health problem and what does not.

• Although CPSC has case study information for some 200 U–F foam complaints, in only 17 percent of the cases are doctors willing to link specific symptoms to urea-formaldehyde. Nor do the case studies always indicate whether good installation practice has been followed. For instance, sometimes a case study will specify that U–F foam was installed in an attic or interior wall, areas clearly prohibited by our standards. Many times, however, no mention is made of where the material is installed or under what conditions. While there is little question that there is a causal connection betwen U–F foam and certain health problems, it is difficult to draw definitive conclusions from the case studies regarding what measures are appropriate to deal with these problems.

• Because U–F foam shrinks after installation, FTC questioned the thermal performance of the material. To ensure that the thermal performance of U–F foam was not misrepresented, DOE originally proposed a 40 percent derating of the R-value to account for shrinkage. The 40 percent derating elicited considerable negative commentary from manufacturers and contractors (discussion of this follows). Even if, however, a 40 percent derating is justified, the R-value is greater than other materials included in the RCS program. (Glass fiber loose fill per 1" thickness @75°F = 2.2hft²F/Btu; U–F foam per thickness @75°F = 4.2hft²F/Btu × 60% = 2.52hft²F/Btu) (based on "Assessment of Thermal Insulation Materials and Systems for Building Applications," June 1978, BNL–50862). DOE's primary concern is that the R-value of the material not be misrepresented. Since shrinkage has considerable impact on the resulting thermal performance, this must be taken into account.

(c) In some installations, there are no acceptable substitutes for U–F foam. U–F foam can be installed through a smaller nozzle than other insulations and can, therefore, be applied through the joints in brick or block constructions. Because the material is denser than loose fill materials, it fills small cavities, especially those with obstructions, much more completely. Eliminating U–F foam from the RCS program would eliminate an important conservation material.

(d) DOE's interim U–F foam standards do not preempt States from taking any legal or legislative action they deem appropriate to restrict its use or sale. Also, it does not prevent CPSC from taking any more stringent regulatory action since any such action by CPSC will supersede our standards.

General Technical Issues

A. *Tolerable Limits of Formaldehyde Exposures.* Several commenters, including Consumer Product Safety Commission (CPSC) and the Environmental Protection Agency (EPA), urged the Department of Energy (DOE) to address the significance of establishing and monitoring exposure limits to formaldehyde. Several European countries have either proposed or established such limits between 0.1 ppm and 0.4 ppm. However, a number of considerations affect the practicality of this.

First, it is very difficult to measure low levels of formaldehyde with any degree of accuracy at a reasonable cost. Results of accepted measurement procedures, including the NIOSH method, vary substantially at low level concentrations. Secondly, those European countries which have established limits, do not enforce them because they have no practical mechanism to do so. In the case of U–F foam insulation, formaldehyde measurements would have to be taken before and one or more times after installation.

Lastly, even if formaldehyde levels could be measured and these measurements could be enforced, there is still no agreement on what an acceptable level should be. The way people react to formaldehyde varies dramatically from individual to individual. For instance, some small segment of our population, estimated by the National Academy of Sciences (NAS) at 4.5 percent to 7.8 percent, will react more severely than normal individuals to lower concentrations of formaldehyde. They will be affected by levels that go unnoticed by the majority of our population. The NAS, under contract to CPSC to develop formaldehyde levels, concluded that ". . . there is no population threshold for the irritant effects of formaldehyde in humans." (See "Formaldehyde—An Assessment of Its Health Effects," prepared by NAS, March 1980 for CPSC. CPSC, 5401 Westbard Avenue, Washington, D.C. 20207.) In light of this, DOE has made no attempt to duplicate or expand the work done by NAS. If, however, either CPSC or EPA recommend a formaldehyde level and practical, cost-effective means of monitoring it, DOE would incorporate them into the RCS program.

B. *Off-Gassing of Formaldehyde.* DOE acknowledges that formaldehyde limitations in the resin and fresh foam as described in the standards will not guarantee that off-gassing will not take place. It will, however, address some of the problems with such off-gassing. Factors recognized as contributing to formaldehyde emission problems which can be controlled through material and installation standards are:

—Formaldehyde in the resin;
—Amount of resin in the product;
—Temperature and humidity cycling;
—Shelf-life of the resin and the foaming agent with catalyst;
—Additives.

Each of these factors is addressed under "Specific Technical Issues" with the exception of additives. Additives are not addressed in the DOE standard but are currently being studied under a research grant from CPSC to the Franklin Research Institute. Recent findings established that the free formaldehyde content of the resin has a direct bearing on initial formaldehyde odor problems reported for some U–F foam installations. (See "Problems Associated with the Use of Urea-Formaldehyde Foam for Residential Insulation," by K. R. Long, D. A. Rierson, S. T. Brennan, C. W. Frank, and R. A. Hahne; ORNL/SUB 7559/1.)

Sources of formaldehyde emission from U–F foam are known to emanate from two sources: (a) the free formaldehyde content of the resin and the fresh foam. (b) hydrolyzable formaldehyde resulting from hydrolysis of methylol and other chemical bonds in the cured foam under certain conditions of ambient temperature and humidity over time.

While adoption of material and installation standards will not guarantee a trouble-free installation, DOE believes they will address some of the problems associated with formaldehyde off-gassing and thus reduce the overall potential of formaldehyde problems in residential applications.

C. *Practicality of Standards.* CPSC questioned whether the DOE installation standard was practical and capable of being met. DOE maintains it is practical and that the certification requirements in § 456.810 will go a long way to ensuring that installers are capable of meeting them. Certification requirements include successful completion of an extensive training program and a comprehensive examination with annual refresher courses and examinations. They also require manufacturers to conduct on-site observations of all U–F installers and equipment checks.

Specific Technical Issues

Definitions. The proposed standard defined the person generally recognized as the installer of U–F foam installation as the manufacturer because he actually manufactures the insulation at the job site from components supplied to him. The insulation supplier was that person who supplied U–F foam components to installers and distributors. Many contractors complained that by being labeled manufacturer, they would have to accept product liability as well as responsibility for the installation process. They were also concerned their insurance rates would reflect this and increase accordingly. DOE agrees with the contractors that the definitions placed more responsibility on them than they should have to bear. That person who combines the foam components and installs the foam is now called the "installer." In addition, the proposed standard also defined that person who furnishes the U–F foam components to distributors and installers as the supplier. This designation has been changed in the Interim Final Rule to "manufacturer." This was done to ensure consistency with the rest of the Final Rule.

Labeling. Comments on labeling were varied. At least 21 people commented. Most were representatives of the U–F foam industry who felt that the warning label proposed by DOE was discriminatory and not within the jurisdiction of DOE. Other commenters, including CPSC, stated that the warning label was not severe enough and recommended that the RCS rule be amended to require that all listed contractors have homeowners sign a form prior to signing their contract to show thay had been presented with the warning.

DOE has determined that the 200 CPSC case studies of odor or health problems allegedly resulting from U–F foam installations are sufficient justification for a disclosure notice. No other insulation material has resulted in this level of complaint; hence DOE does not require a disclosure notice for other insulation materials. Additionally, DOE has received many telephone calls from homeowners who want to verify whether or not the insulation product they are considering contains formaldehyde. Apparently, many times they are told explicitly by the salesman that the product does not contain formaldehyde when, in fact, it does. The disclosure notice will provide homeowners with sufficient information upon which to make a decision about what is best for them.

Subsequent to DOE's proposed standards which contained a warning statement, CPSC proposed a mandatory U–F foam disclosure notice. If the Consumer Product Safety Commission determines a final notice is necessary, it will take several months to become effective. Because DOE is attempting to minimize redundant labeling requirements, DOE included in the interim standard, a notice similar to that proposed by CPSC. With relatively few changes, the notice meets the intent of that originally proposed. If CPSC finalizes their notice requirement making it mandatory for all manufacturers to comply, DOE will delete its labeling requirement.

CPSC suggested that all manufacturers label their products as to batch and lot number. DOE accepts this suggestion so that test results can now be related to specific products. This should not place any additional burden on manufacturers since many are already including this on their products.

DOE has required U–F foam contractors to present the disclosure notice to homeowners prior to the signing of the contract. Homeowners will not be required to sign a statement to that effect since it is unclear what responsibility that may create for the homeowner should an odor problem result.

Laboratory Testing. Several commenters suggested that DOE should require U–F foam manufacturers to submit their materials to a independent laboratory to certify compliance with the standard.

In the Interim Final Rule, DOE requires manufacturers to submit their material to an independent laboratory and to undergo follow-up testing at least once a year to ensure continued quality control. All test procedures described in § 456.810 must be performed on the same batch of material. This is to ensure that manufacturer's product can meet all tests simultaneously. One commenter stated that this requirement placed an unreasonable burden on the manufacturer because if the material failed one test, the entire battery of tests would have to be rerun at the manufacturer's expense. DOE recognizes the difficulty this requirement presents, but determined it was essential that one sample of material could meet all tests.

Althought DOE has not to date required the same lab certification for other insulation materials, we will consider it.

Application Limitations. In the proposed standard, DOE limited application of U–F foam to exterior walls. The National Association of

Home Insulation Contractors (NAHIC) recommended that DOE prohibit applications in mobile homes, knee walls, and below grade areas. DOE agreed with this suggestion for several reasons. Mobile homes with an impermeable, exterior, metal skin are more likely to experience off-gassing of formaldehyde to the interior. Below grade areas are more likely to have higher relative humidities which may cause hydrolysis of U–F foam components resulting in off-gassing. Attic knee wall areas are likely to result in the same problem as attics. High temperatures and humidities in attics may cause deterioration of the foam or hydrolysis of components resulting in off-gassing of formaldehyde vapors. Because formaldehyde is denser than air, it may sink into the living area of the house.

In the Interim Final Rule, DOE therefore prohibits application of U–F in any area but exterior sidewalls.

R-value Derating. In the Proposed Rule, DOE suggested a 40 percent R-value derating for U–F foam to account for shrinkage. This was based on several field measurements and laboratory data. Experimental work done by Dynatech R/D Company showed a "direct relationship between effective thermal performance and size of air gap of the order of 5 percent for each 1 percent of shrinkage . . . ." The results confirm the validity of the NBS Derating analysis for deriving effective resistence of materials which shrink within a cavity. (See "The Effective Thermal Performance of an Insulated Standard Stud Wall Containing Air Gap" by R.P. Tye, A.O. Desjarlairs, J.G. Bourne, and S.C. Spinney, Dynatech R/D Company, Cambridge, Massachusetts.)

Other experimental work conducted by the National Research Council of Canada shows a similar relationship between linear shrinkage and R-value reduction. It showed, for instance, that if the material shrank 6 percent, reduction in R-value would be about 29 percent. (See September 4, 1979 Minutes of "Committee on Urea-Formaldehyde Thermal Insulation," Canadian Specifications Board, 1105–51–8P110.)

DOE's experience with U–F foam has been that the material always shrinks, but there is considerable variation in the amount of shrinkage. The proposed 40 percent derating was based on DOE's estimate that 8 percent shrinkage was common. This was the experience at the NBS Bowman House (See "Retrofitting an Existing Wood-Frame Residence for Energy Conservation—An Experimental Study" D.M. Burch and C.M. Hunt, NBS, Washington D.C. 20234, NBS Building Science Series 105.) In addition, DOE opened 43 wall cavities of homes in Portland, Oregon, which had been reinsulated by U–F foam. Results showed that the overall mean shrinkage was 10.5 percent from 32 homes while the mean width shrinkage was 8.1 percent from 41 homes. (See "A Field Study of Moisture Damage in Walls Insulated Without A Vapor Barrier" Oregon Department of Energy, November 1979, ORNL/Sub–78/97726/1.)

More recent data has shown that the shrinkage may be more in the order of 6 percent although even this is speculative. An NBS sponsored study of 17 homes measured an average shrinkage of 6 percent. (See "A Field Study of the Performance Properties of Insulation Used to Retrofit Cavity Walls of Residences" presented at ASHRAE/DOE Conference December 13, 1979.)

In addition, a field study done at the University of Connecticut also showed shrinkage of 6 percent on a test house. (See "The Thermal Resistance of In-Situ Urea-Formaldehyde Foam Insulation" by Peter W. McFadden, Kaveh Azar, and Thaddeus J. Zebrowski, University of Connecticut, March 1980.)

Based on this data, DOE has reduced the derating from 40 percent to 30 percent. This assumes an average shrinkage of 6 percent with a ratio of shrinkage to reduced thermal performance of 1:5. DOE considered giving to manufacturers the option of the 30 percent derating or the opportunity to demonstrate or more accurate, product-specific derating value. This did not appear practical since there are no standardized procedures for accelerated aging to U–F foam. Standardized procedures would be difficult to develop since foam products do not mature at the same rate, but instead are dependent upon ambient conditions and additives. Although DOE has heard that low shrinkage foams are being manufactured, manufacturers have never provided verification of these reports. The 30 percent derating, therefore, was determined to be an equitable treatment for U–F foam.

Corrosion. A few comments were submitted on the corrosion test procedure. One commenter stated that the corrosion test was not reproducible. Although little data is available to address this comment, the Ontario Research Foundation found the procedure reproducible when conducted in the same laboratory with the same operator. These standardized conditions cannot be expected under the RCS program. At a later date, DOE would like to include the test procedures for U–F foam in the National Voluntary Laboratory Accreditation Program (NVLAP) sponsored by the Department of Commerce. The NVLAP program accredits laboratories to conduct specific tests. It would assure that accredited laboratories have the capability to conduct a test properly. Some of the uncertainty regarding the validity of test procedures like the one for corrosion may be eliminated if an accredited laboratory conducts the tests. DOE is concerned about the reproducibility of this test as we are about the reproducibility of all corrosion tests. As a result, we are working with the American Society of Testing and Materials (ASTM) to develop one reproducible corrosion test which can be applied to all insulation materials. In the meantime, DOE will retain the test procedure originally proposed with minor modifications. DOE specifies that the foam must cure for 1-week prior to adding the coupons. This is based on experimental work done at Stevens Institute of Technology which shows that it takes close to 1-week to ensure complete curing.

CPSC suggested that, to more closely simulate in situ conditions, the test be conducted by foaming around the coupons instead of placing the coupons between blocks of foam. DOE acknowledges the advantages of both corrosiveness tests and has therefore added a fresh foam test in addition to that foamed block test which was proposed. The fresh foam test is identical to the proposed by the ASTM task force. The requirement for both tests will give a better indication of the corrosiveness of foam than either of the tests could provide separately because U–F foam is considered most corrosive immediately after foaming. However, if U–F foam is subjected to high humidity and somewhat elevated temperatures (90°C) as may be found throughout the life of the installed foam, it can still be corrosive.

End-Use Thickness. Four commenters stated that DOE's requirements for a 3-inch test sample to determine thermal resistancy was inappropriate since most stud cavities would accommodate 3½-inch of U–F foam. They also complained that requiring a 3-inch test sample with a variance of 1 mm was a level of precision difficult to achieve by slicing or cutting U–F foam samples. DOE originally required the 3-inch sample so that if the material shrank after foaming a 3½-inch cavity, it would still be possible to acquire a 3-inch sample. If a 3½-inch sample were required, this may not be possible. In order to be responsive to these comments, DOE has modified the procedure so that manufacturers may submit a sample a

minimum of 3-inch in thickness, as long as the thickness is specified. With this requirement, a variance of 1 mm is no longer necessary and manufacturers are not precluded from using 3½-inch samples.

Moisture Absorption. There were two separate comments on the moisture absorption tests. One expressed confusion over whether both the floating and methyl violet tests were required or whether a manufacturer had the option of selecting one test over the other. Two other commenters suggested deleting the methyl violet test since it duplicated the floating test.

DOE intended in the proposed standard that manufacturers use both moisure absorption tests. DOE agrees with the commenters, however, that both tests are not necessary and will only add to the cost of testing. The methyl violet test has therefore been deleted in the interim standard.

In the Final Rule, DOE also clarified the test procedure by stating that the foam samples must "stand at room temperature until three successive daily weighings vary no more than 1 percent." In their comments, CPSC claimed the time frame within which a test must be conducted was missing from many of the test procedures. The additional statement in the water absorption test procedure addresses this.

Formaldehyde Content in Fresh Foam. Several suppliers suggested an alternative test procedure for determining the formaldehyde content of the fresh foam. The suggested procedure is also contained in the ASTM draft U–F foam standard. It contains minor modifications which DOE believes will make the test more reproducible, more sensitive, and faster. DOE has, therefore, incorporated the modified test procedure into the interim standard.

One commenter requested that DOE specify a deviation range for the required 0.3 percent formaldehyde content of fresh foam. DOE maintains that no variance is needed since manufacturers may already go as far below 0.3 percent as they wish (as long as they pass the other required test procedures); they just cannot exceed the 0.3 percent limit.

CPSC also expressed concern about a lack of time limitations within which this test must be conducted. DOE agrees that these limitations are particularly important when determining the formaldehyde content of the fresh foam. In the Interim Final Rule, DOE sets these limits at between 15 minutes and 1 hour. This falls within the decay curve established at the University of Iowa and will ensure that measurements are taken prior to the drying phase when formaldehyde begins to release.

Wet Density. Many commenters objected to the wet density limitations in the proposed standard. DOE originally specified that the wet density should be between 2.5 lb/ft ^{3} and 5.5 lb/ft ^{3}. Some commenters suggested other limits and some suggested that the limits remain unspecified by DOE, and at the manufacturer's discretion. DOE agrees with the latter approach since wet density limits must correlate with dry density. Because there is sufficient variation in density from product to product, DOE determined to leave the limitations up to each manufacturer. The interim standard contains a lower dry density limit only. Manufacturers must specify wet density limits and upper dry density limits on a product-by-product basis.

Set Time. Many commenters suggested many alternatives to the set time limits contained in the Proposed Rule. DOE proposed that the set time should be between 20–60 seconds. DOE has reduced the lower set time to 10 seconds to accommodate most manufacturers. A set time of 10–60 seconds will aid in troweling applications and is also acceptable in wood frame applications a set time of 10 second is probably too short for masonry cavity constructions and installers will have to adjust their formulations accordingly.

Training and Certification. CPSC suggested that manufacturers be responsible for conducting a specified number of on-site inspections of installers. DOE agrees that this could be an important element in ensuring that installers are using good practice. DOE, therefore, has included a requirement for manufacturer to conduct an on-site observation of all installers prior to recertification to ensure they are following procedures contained in the training program. (See § 456.810(d)(12).)

Fungal Growth. DOE is concerned about increasing evidence of fungal growth within U–F foam. It is not addressed in these standards since no test method has been validated for determining potential fungal growth in U–F foam. It will be addressed, however, in future DOE research projects where both laboratory and field work are planned to develop this test method.

Temperature/Humidity Resistance. DOE is also concerned about the effect of temperature and humidity on U–F foam. High temperatures and humidities can cause deterioration of the foam insulation and, therefore, affect the durability of the material. High humidities may also cause hydrolysis of foam components which result in off-gassing of formaldehyde vapors. DOE, therefore, believes that some measurement of temperature and humidity resistance is an important element in a U–F foam standard. Although the draft ASTM U–F foam standard contains a test procedure for measuring temperature/humidity resistance, no data is presently available to validate it. DOE is, therefore, working to develop such a test procedure and will incorporate one into the U–F foam standard at the appropriate time.

C. Interim Final Installation Standard for Urea-Formaldehyde Foam Insulation

Included in this Interim Final Rule is an interim installation standard for U–F foam. Comments on the proposed standard were varied and are addressed individually below.

One commenter requested that the note in the Proposed Rule containing specific hazards associated with U–F foam insulation be deleted as it was with all other types of installation. DOE agrees with this comment and has deleted the specific hazards noted in the Interim Final Rule.

Several contractors and manufacturers questioned the appropriateness of the equipment testing procedures in the proposed installation standard (§ 456.909). Because the testing procedures require such large quantities of material (40 gallons), DOE agrees that it is impractical to require installers to conduct the tests with the frequency described in the Proposed Rule. In the Interim Final Rule, DOE changed the provision so that manufacturers are now responsible for recommending equipment to their installers that meets the equipment test requirements described in § 456.810(f)(1) when tested in accordance with the test procedures described in § 456.810(f)(2). The installer is still responsible for using only equipment recommended by the manufacturer.

Several commenters questioned the need for a uniform cell size of 1 mm or less. DOE agrees that it is not the size of the cells that determines the quality of the foam so much as the uniformity of the cell size. The provisions for a uniform cell size of 1 mm or less was therefore changed in the Interim Final Rule to a requirement for uniform cell distribution without stipulating cell size.

One commenter suggested that since U–F foam is combustible, it should be protected with a standard fire-rated finish material. Because U–F foam, like other foam plastic insulations, must have a flame spread of no more than 75 when tested in accordance with ASTM

E–84, DOE agreed other fire safety requirements should be compatible. DOE requires that other foam plastic insulations be protected on the interior by a layer of ½-inch gypsum board (or equivalent) when tested in accordance with ASTM E–119. An identical requirement was therefore added to the U–F foam installation standard in the Interim Final Rule.

The Proposed Rule contained a provision which required installers to leave entry holes open for 72 hours after foaming. This was included so that initial formaldehyde vapors would have a means to exfiltrate to the exterior of the house. It was also included because it was thought to aid in the curing of a foam. Most everyone who commented on the U–F foam standards complained about this provision. Contractors were concerned about damage to or loss of siding, shingles, or exterior building materials in the interim 72 hours as well as the inconvenience of making two trips to the job site. Manufacturers stated that open entry holes would not aid in the curing process, but suggested vent plugs as a compromise. Because DOE has a data to verify the effectiveness of open entry holes following installation, DOE has deleted this provision in the Interim Final Rule.

The Proposed Rule required that special attention be paid to wall cavities which contain dissimilar metals because wet foam which is mildly acid can cause rapid electro-chemical corrosion. U–F foam in wall cavities containing both copper plumbing pipes and aluminum electric wiring may promote this type of corrosion. One commenter doubted that sufficient dissimilar metals would be found in the wall. Because DOE continues to recognize this situation as a protential problem, the provision was retained in the Interim Final Rule.

Several commenters stated that the proposed requirement of turning off all electric power circuits located in exterior walls was unnecessary. DOE agreed with this suggestion since the resistivity requirements contained in the material standard are sufficiently low to preclude any opportunity for shock hazards.

Other changes made to the installation standards such as limitations on wet density specification and set time also affect the manfacturer of U–F foam, and are included in the material standard also, and are described under "B. Material Standard for Urea-Formaldehyde (U–F) Foam Insulation."

III. Regulatory Analysis and Urban Impact Assessment

The President, by Executive Order 12044, has directed agencies of the executive branch to conduct a Regulatory Analysis of regulations which they prepare that are likely to have a major economic impact. In accordance with OMB Circular A–116, and Urban and Community Impact Assessment should be prepared when the Proposed Rule is a major policy and program initiative. This assessment should be incorporated into the Regulatory Analysis.

DOE determined that the Residential Conservation Service Program, authorized under Title II, Part 1 of the National Energy Conservation Policy Act, was a major action which required preparation of Regulatory Analysis and an Urban and Community Impact Assessment. Consequently, the Department prepared the two analyses in draft in conjunction with the publication of the Proposed Rule for the RCS program on March 19, 1979 (44 FR 16546). These analyses were finalized for publication in conjunction with the Final Rule which was published November 7, 1979 (44 FR 64602). The final Regulatory Analysis, which incorporates the final Urban and Community Impact Assessment, includes analysis of this Interim Final Rule.

A single copy of the Final Regulatory Analysis may be obtained by writing: Mr. James R. Tanck, Chief, Building Applications and Incentives Branch, Department of Energy, Conservation and Solar Energy, 1000 Independence Avenue, S.W., Room GH–068, Washington, D.C. 20585.

IV. Environmental Impact Statement

In accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. 4321 *et. seq.*, DOE prepared an Environmental Impact Statement for the entire Residential Conservation Service Program. The subject matter of this rulemaking was evaluated in the programmatic Environmental Impact Statement (DOE/EIS–0050) was published in the **Federal Register** on November 7, 1979, (44 FR 64602). A copy of the final Environmental Impact Statement may be obtained by writing: Mr. James R. Tanck, Chief, Building Applications and Incentives Branch, Department of Energy, Conservation and Solar Energy, 1000 Independence Avenue, S.W., Room GH–068, Washington, D.C. 20585.

V. Record of Decision

In accordance with section 1505.2 of the Council on Environmental Quality Regulations Implementing the National Environmental Policy Act (40 CFR 1500–1508), the Department is required to publish a Record of Decision at the time a final decision is reached on actions for which an environmental impact statement was prepared. This section is intended to fulfill these requirements for the subject interim final rulemaking.

A complete discussion of the decision reached by this rulemaking and the background information supporting it is contained in the "Summary," "Introduction" and "Standards" sections of the preamble. A number of alternatives to the interim final rulemaking were considered, including a "no action" alternative, a further delay in promulgating the rule, and various modifications to the specific technical provisions in the rule regarding material content of the U–F foam and the installation procedures associated with its use. For the reasons discussed in the "General Technical Issues" section of the preamble, the Department determined that the environmentally-preferred alternative is the action published herein.

VI. Consultation With Other Federal Agencies

In preparing this Interim Final Rule, issues and options were reviewed by representatives of the National Bureau of Standards and the Consumer Product Safety Commission.

VIII. Contractor Contributions to the Rulemaking

The following contractor contributions were made to this rulemaking: Hittman Associates, Inc., and the Agricultural Medicine Department of the University of Iowa assisted in the development of the interim final material and installation standards for U–F foam.

Authority: Part 1 of Title II of the National Energy Conservation Policy Act, Pub. L. 95–619, 92 Stat. 3206 *et seq.*, as amended by Title V, subtitle B of the Energy Security Act, Pub. L. 96–294, 94 Stat. 611 *et seq.*, Department of Energy Organization Act, Pub. L. 95–619, 91 Stat. 565 *et seq.*, 42 U.S.C. 7101 *et seq.*

In consideration of the foregoing, the Department of Energy amends Chapter II, Title 10, Part 456 of the Code of Federal Regulations, as set forth below.

Issued in Washington, D.C., September 11, 1980.

Maxine Savitz,

Deputy Assistant Secretary for Conservation, Conservation and Solar Energy.

1. 10 CFR Part 456 is amended by revising the following entries to the Table of Contents:

* * * * *

Sec.

456.810 Interim final standard for urea-formaldehyde foamed-in-place insulation.

* * * * *

456.909 Interim final standard practice for the installation of urea-formaldehyde foamed-in-place insulation.

2. 10 CFR Part 456 is amended by adding § 456.810 to read as follows:

§ 456.810 Interim standard for urea-formaldehyde foamed-in-place insulation.

(a) *Scope.* This section presents an interim standard which applies to urea-formaldehyde foamed-in-place insulation of existing residential buildings. This material is approved for exterior sidewall application only, and is not approved for use in attics, above ceilings, under floors, in knee walls, in mobile homes, or in below-grade applications.

(b) *Definitions.* (1) "Urea-formaldehyde foam insulation" (U–F foam) is a cellular plastic material generated in a continuous stream by mixing the components which are a urea-formaldehyde resin, air, and a foaming agent.

(2) "Foamed-in-place" means sprayed or pumped in place to form rigid or semi-rigid insulation in its permanent location.

(3) "Insulation installer" (installer) means the person who combines these component materials and foams the insulation in place.

(4) "Insulation Manufacturer" (manufacturer) means the organization or person that supplies the resin, foaming agent, and other ingredients to the foam insulation distributor and/or installer.

(5) "Vapor barrier" means any material (as defined in ASTM Designation C–755–73) that has a water vapor permeance (perm) rating of one (1) or less.

Note.—The following materials, upon proper application, constitute vapor barriers. Asphalt impregnated kraft paper, aluminum foil, plastic film, and paint and wallcoverings which are labeled by the manufacturer as having a perm rating of one (1) or less when applied in accordance with the manufacturer's instructions.

(6) "Independent test laboratory" means a test facility which has no organizational tie or financial interest in a manufacturer, or in the promotion of the type of product being tested. It must have sufficient breadth of interest or activity so that the loss or award of a specific contract for test services would not be a substantive factor in financial well-being of the facility. It may offer test services under contract or on a fee basis and may be a profit or non-profit activity.

(7) "ANSI/ASTM B 152–79" means ANSI/ASTM Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar.

(8) "ANSI/ASTM B 446–75" means ANSI/ASTM Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy Rod and Bar.

(9) "ASTM C 177–76" means ASTM Standard Test Method for Steady State Thermal Transmission Properties by Means of the Guarded Hot Plate.

(10) "ASTM C 236–66 (Reapproved 1971)" means ASTM Standard Test Method for Thermal Conductance and Transmittance of Built-Up Section by Means of the Guarded Hot Box.

(11) "ASTM C 518–76" means ASTM Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter.

(12) "ASTM D 257–76" means ASTM Standard Test for D–C Resistance or Conductance of Insulating Materials.

(13) "ASTM D 1622–63" means ASTM Standard Test Method for Apparent Density of Rigid Cellular Plastics.

(14) "ASTM E 84–79A" means ASTM Standard Test Method for Surface Burning Characteristics of Building Materials.

(c) *Coverage.* The component material manufacturer is responsible for ensuring that the requirements contained in this section have been met in all operations through and including time of delivery to the insulation installer.

(d) *Material requirements.* (1) *Thermal resistivity.* Thermal resistivity shall be tested in accordance with the test method described in paragraph (f)(2) of this section. Thermal resistivity for any given specimen of U–F foam insulation shall not be more than 5 percent below the arithmetic average of the resistivities of the foam specimens tested. Effective thermal resistivity of U–F foam shall be computed as 70 percent of the laboratory thermal resistivity value, and shall be the value reported to the public.

(2) *Fire safety.* The flame spread classification of U–F foam insulation shall not exceed 75, when tested in accordance with ASTM E 84.

(3) *Corrosiveness.* When tested as specified in paragraph (f)(3) and (f)(4), the corrosion rates shall not exceed the values specified in Table XIII below.

Table XIII

Metal	Corrosion Rate
Carbon Steel	0.15 mm/yr (0.006 in./yr)
Copper	0.025 mm/yr (0.001 in./yr)
Galvanized Steel	0.09 mm/yr (0.0035 in./yr)
Aluminum	0.025 mm/yr (0.001 in./yr)

The two corrosion tests shall be conducted on the same batch of foam manufactured at the same time and place.

(4) *Density.* (i) The dry density of U–F foam insulation shall be no less than 10.4 kg/m^3 (0.65 lb/ft^3) when tested in accordance with ASTM D 1622.

(ii) The manufacturer shall specify upper and lower limits on the wet density of U–F foam insulation, using the test method specified in paragraph (f)(5) and assure that wet density is within the specified limits.

(iii) The manufacturer shall specify upper and lower limits on the specific gravity of dilute resin so that the installer is able to measure the specific gravity of the dilute resin with a clean hydrometer prior to foaming, and assure that is is within the specified limits.

(5) *Water absorption.* Under conditions specified in paragraph (f)(6) of this section, the water absorption of U–F foam insulation shall not exceed 15 percent by volume.

(6) *Free formaldehyde content.* (i) The free formaldehyde content of the resin used in U–F foam insulation shall not exceed 0.5 percent by weight when tested as specified in paragraph (f)(7).

(ii) The free formaldehyde content of fresh U–F foam shall not exceed 0.3 percent by weight when tested as specified in paragraph (f)(8).

(7) *Setting time.* U–F foam insulation shall set in not less than 10 seconds and not more than 60 seconds when tested in accordance with paragraph (f)(9).

(8) *Volume resistivity.* The volume resistivity of fresh U–F foam shall be not less than 5 kΩ-cm when tested as specified in paragraph (f)(10).

(9) *Water drainage.* U–F foam insulation shall manifest no water leakage from a plywood cavity when tested in accordance with paragraph (f)(11) of this section.

(10) *Shrinkage.* U–F foam insulation shall not shrink more than 4.0 percent in any direction when subjected to the conditions specified in paragraph (f)(12) of this section.

(11) *Labeling.* (i) Containers of urea-formaldehyde resin and foaming agents shall have labels showing storage temperatures and dates (shelf-life) after

which resin and foaming agent are not usable.

(ii) The following notice shall be provided to installers to present to residents prior to the signing of a contract for installing U–F foam insulation:

Safety Information

This product may release formaldehyde gas into your home over a long period of time.

Formaldehyde gas may cause eye, nose, and throat irritation, coughing, shortness of breath, skin irritation, nausea, headaches, and dizziness. People with respiratory problems or allergies may suffer more serious reactions, especially persons allergic to formaldehyde.

The symptoms may appear immediately, or not until months after installation.

The U.S. Department of Energy recommends application of U–F foam in exterior sidewalls only, because other installations may increase the likelihood of formaldehyde release into the home. In some instances the formaldehyde gas cannot be controlled by ventilation or other means.

If you have health concerns, call your doctor. Also, contact (installer-phone) or (material supplier-phone).

(12) *Training requirements.* (i) The manufacturer of the U–F foam components shall train and certify the installers of U–F foamed-in-place thermal insulation. An approved training course and comprehensive examination shall require and demonstrate proficiency in the following:

(A) Overview of heat transfer and thermal insulations
(*1*) Condensation control/vapor barriers
(*2*) Effects of moisture on thermal insulations
(*3*) Air infiltration
(B) Overview of U–F foam insulation
(*1*) Physical properties
(*2*) Mechanical properties
(*3*) Thermal properties
(*4*) Chemical properties
(C) U–F foam technology
(*1*) Manufacture and composition of U–F foam components, i.e., resin and catalyst solutions
(*2*) Chemical reactions during production of U–F foam and of final foamed product
(*3*) Field manufacture of U–F foam *in situ*
(D) Post-installation curing of U–F foam
(*1*) Shrinkage
(*i*) Normal
(*ii*) Excessive
(*2*) Formaldehyde release
(*i*) Inherent post-installation release
(*ii*) Possible delayed release
(*iii*) Solids content of components and foam
(*iv*) Factors affecting rate of drying
(E) Installation procedures
(*1*) General guidelines
(*i*) Vapor barriers
(*ii*) Wall venting
(*iii*) Drilling and plugging requirements
(*iv*) Problem installations
(*2*) Specific guidelines (covers opening and closing techniques and equipment and tools to use)
(*i*) Brick-on-brick
(*ii*) Concrete block
(*iii*) Brick veneer on frame construction
(*iv*) Drill and plug
(*v*) Wood shingle and wood shake siding
(*vi*) Slate shingles
(*vii*) Aluminum, vinyl, and steel siding
(*viii*) Clapboard wood siding
(*ix*) Metal clad buildings
(*x*) Stucco and pebbledash
(*xi*) Imitation brick asphalt roll or sheet
(*xii*) Balloon construction
(*xiii*) Pipe chases
(*xiv*) Windows and door frames
(F) Problem applications
(*1*) Knee walls
(*2*) Mobile homes
(*3*) Ceilings
(*4*) Below grade
(G) Proper cavity fill techniques
(*1*) Stud cavity
(*i*) Check for obstructions
(*ii*) How to determine number of holes per cavity necessary for complete fill
(*iii*) Methods of preventing over pressurized or ruptured walls
(*iv*) Demonstration of proper fill technique
(*2*) Continuous cavity, i.e., brick-on-brick
(*i*) Methods of preventing overpressurized or ruptured walls
(*ii*) Demonstration of proper fill technique
(*3*) Other cavities
(*i*) Methods of preventing overpressurized or ruptured walls
(*ii*) *Demonstration of proper fill techniques*
(H) Resin and foaming agent/catalyst handling
(*1*) Storage conditions
(*2*) Solution temperatures during application
(*3*) Shelf life
(*4*) Safety precautions
(*5*) Shipping requirements
(I) Practical demonstration
(*1*) Proper foaming technique
(*i*) Pre-foaming quality control checks
(*ii*) Pre-installation quality control checks
(*iii*) Quality control checks during installation
(*2*) Trouble shooting off-specification foam
(*i*) Off-ratio foam
(*ii*) Incorrect density foam
(*iii*) Over aged resin
(*iv*) Incorrect solution temperatures
(*v*) faulty, malfunctioning, or inadequate equipment
(*vi*) Overacidified or underacidified foaming agent
(*vii*) Effects of using equipment not properly maintained
(J) Equipment
(*1*) Manufacturer's recommended equipment
(*2*) Proper care and maintenance
(*3*) Troubleshooting
(K) Recordkeeping
(*1*) Required disclosures to consumer
(*2*) Manufacturer's required recordkeeping

(13) *Certification.* Upon successful completion of the manufacturer's training programs and a comprehensive examination, installers may then be certified to apply U–F foam insulation.

(i) The manufacturer shall issue application licenses to the certified dealers and maintain a current roster of its licensed installers.

(ii) Annual refresher courses and re-certification examinations shall be required for each installer to maintain his certification.

(iii) The manufacturer shall conduct one on-site observation of a U–F foam installation of each of its certified installers at least once per year to ensure that the installer is using the procedures and techniques demonstrated in the training program. During the on-site inspection, the manufacturer shall test the installer's equipment to ensure proper functioning.

(iv) The manufacturer of the U–F foam components shall recommend to installers only equipment which has been certified by the equipment manufacturer as meeting the testing requirements of paragraph (g) of this section. During the on-site inspection described in paragraph (c) of this section, the manufacturer shall ensure that this equipment is being used by the installer.

(v) Installers trained by a manufacturer other than their current manufacturer must use equipment that complies with the current manufacturer's specifications and must successfully complete that manufacturer's certification requirements. Complete re-training is not necessary, but should depend on the current proficiency of the installer.

(vi) The manufacturer of the U–F foam components shall provide materials control and installation instructions to installers.

(e) *Laboratory testing.* The manufacturer shall have a continuing annual program of retesting by an independent laboratory to assure compliance with these standards. Laboratory testing must include all the materials test methods specified in paragraph (f).

(f) *Materials test methods.* (1) *Preparation of specimens.* Neither the specimen composition nor foaming conditions shall be altered to produce qualifying samples for the tests required in this section. All tests described in this section shall be conducted on the same batch of U–F foam insulation (made from the same resin, foaming agent, and additives) and under the same conditions. Unless otherwise specified in the following test procedures, the foam shall be prepared and applied in accordance with the manufacturer instructions using specified equipment. The temperature of the unreacted materials prior to foaming shall be between 15° and 32°C (59° and 90°F). Unless otherwise specified, specimens shall be foamed at ambient conditions of 23±2°C (73±4°F) and 50±5 percent relative humdity into closed cavities constructed of (nominal) 2×4 inch studs (51×102 mm) and ½ inch (13 mm) thick exterior grade plywood. Maintain test specimens in the closed cavities in vertical positions at 23±2°C and 50±5 percent relative humidity for 28 days prior to testing. Then remove specimens from cavities and condition at 23±2°C (73±4°F) and 50±5 percent relative humidity until a constant weight (±1.0 percent) is maintained over a three day period.

(2) *Test method for thermal resistivity.* (i) The Laboratory value of thermal resistivity shall be determined as specified in ASTM C 177, ASTM C 518 or ASTM C 236 using specimens not less than 75 mm (3 in.) thick, a mean temperature of 24°C (75°F) and a mean temperature differential across the specimen of 22±3°C (72±5°F). In cases of a question, ASTM C 177 shall be used. Specimen surfaces shall be either those obtained during foaming or those obtained by slicing the specimen to remove not more than 5 mm from each side.

(ii) The effective thermal resistivity shall be computed as 70 percent of the laboratory thermal resistivity value determined by the preceding paragraph.

(3) *Test method for corrosiveness*—1 (i) The following apparatus and materials shall be used to test for corrosiveness:

(A) Oven capable of maintaining 40±2°C (104±4°F).

(B) Small container, approximately 90 mm in diameter, 50 mm high (3.6 in. diameter, 2 in. high) made of inert material such as polypropylene and equipped with a lid so designed that water condensing on it will not drip but will run to the walls of the container. The container shall be designed such that it is not potentially hazardous after it has been sealed at room temperature and heated to 40°C (104°F).

(C) Large container, capable of housing the small container, but which will fit inside the oven.

(D) Test coupons, approximately 50 x 50 mm x 0.0762 mm (2 x 2 x .003 in) thick metal, free of tears, punctures or crimps as follows: 3003 Bare Aluminum, soft temper; ANSI/ASTM B 152–79 type ETP, Cabra No. 110, soft copper; and low carbon, commercial quality, cold rolled shim steel.

(E) Test coupons, approximately 50 x 50 x 1.0 mm (2 x 2 x .04 in.) made from hot dipped galvanized sheet steel conforming to Grade A or B, ANSI/ASTM B 446–75 with a total zinc coating of 275–0, +31 g/m². At least 40 percent of the zinc shall be on any one side of the test coupons. (Metal of this quality is used in the manufacture of truss plates.)

(F) Balance, capable of determining the mass of the galvanized specimen to an accuracy of 0.2 mg.

(G) Distilled water, nitric acid (specific gravity 1.42), ammonium hydroxide (specific gravity 0.90), chromium trioxide, silver nitrate, hydriodic acid, reagent grade chemicals.

(H) Several noncorrosive plastic supports and a 150 g mass.

(ii) Prepare foam specimens from blocks. Allow the foam to cure for at least seven days. Cut a specimen 60 x 60 mm (2.4 x 2.4 in.) square and 15 mm (0.6 in.) thick from blocks such that one 60 x 60 mm (2.4 x 2.4 in.) surface is that obtained from foaming and not slicing the foam. All other surfaces of the specimen shall be obtained by slicing the foam. Surfaces obtained from foaming shall be placed adjacent to the metal specimens in the test.

(iii) Make duplicate tests for each determination. Wash the metal coupons with a laboratory detergent to remove any oil or grease. Rinse the cleaned coupons in flowing water to remove residues. Inspect each coupon for a water-break free surface. A water-break is a separation, beading, or retraction of the water film as the coupon is held vertically after wetting. At no time shall the metal coupons be touched with ungloved hands. Handle the cleaned metal specimens with clean forceps. Hot air dry the coupons at 105°C (221°F). Weigh the coupons and record their masses. Place a noncorrosive plastic screen support in the small container and add 20 ml (deionized) water. Place a foam block on the support at least 5 mm (0.2 in.) above the surface of the water. Place the metal coupon on the foam block, put another foam block on the metal coupon and then place on top of the sandwich a non-corrosive plastic screen and a 150 g mass which shall not block air flow to the top foam block. Seal the small container with a lid. Place the small container in the large container, add sufficient distilled water (approximately 20 ml) to the large container and seal it. Place the assembly in an oven at 40±2°C (104±4°F) for 28 days. Upon completion of the test remove the assembly from the oven and dismantle. Both containers shall not be dry but contain visible water. If there is no water present at the end of the test, then the test shall be repeated. Remove the corrosion products from the metal coupons by the procedures recommended in ASTM G1. Rinse all metal coupons in distilled water and dry. Examine the specimen and control coupons. The controls shall be metal coupons not exposed in the oven but which are cleaned identically to the specimens. Subtract the loss in mass of the controls from the loss in mass of the specimen coupons. For each set of duplicate specimens to meet the requirements of paragraph (d)(3), the spread between results shall not exceed an absolute value equal to 15 percent of the maximum permissible corrosion rate specified for that material and the average of both results shall be below that maximum limit set for that material.

(iv) Calculations. Corrosion rates shall be calculated by the following equation:

$$\text{Corrosion Rate}_{(\text{mm/yr})} = \frac{87.6 \times W}{A \times T \times D}$$

Where:

W = weight loss in mg to the nearest 0.2 mg
A = total surface area in cm^2 to the nearest 0.01cm^2
T = time of exposure in hours to the nearest 0.1 hr
D = density in g/cm^3

(4) *Test method for corrosiveness–2.* The following test procedure utilizes the principle of ASTM G 4 testing method to simulate the actual environment in which pieces of carbon steel, galvanized iron, copper, and aluminum (alloy 6061) will be subjected to an actual field condition. The cleaning and evaluation of the corrosion test specimen shall utilize the recommended practice in Method G 1, and G 46; the resulting data will be evaluated by the recommended practice in Method G 16. This test method is required in addition to test method for corrosiveness–1.

(1) Preparation of Test Coupons. Six (6) test coupons of each material, three (3) coupons each for each test tray, shall be cut or punched from a No. 10 U.S. gauge sheet (approximately 3.5 mm) thick, with a diameter of 3½ inches (88.9 mm) as shown in Figure 1. The test materials shall be cut from sheets of carbon steel, galvanized iron, copper, and aluminum (alloy 6061) and have $1\frac{1}{32}$ inch diameter (11.9 mm) hole drilled in the center and all edges shall be machine finished. Each test coupon shall be stamped with an appropriate letter to identify the material of the coupon, and a number to identify the particular sample. The following letter identification shall be used for the test materials:

a—aluminum
c—copper
s—carbon steel
z—galvanized iron

BILLING CODE 6450-01-M

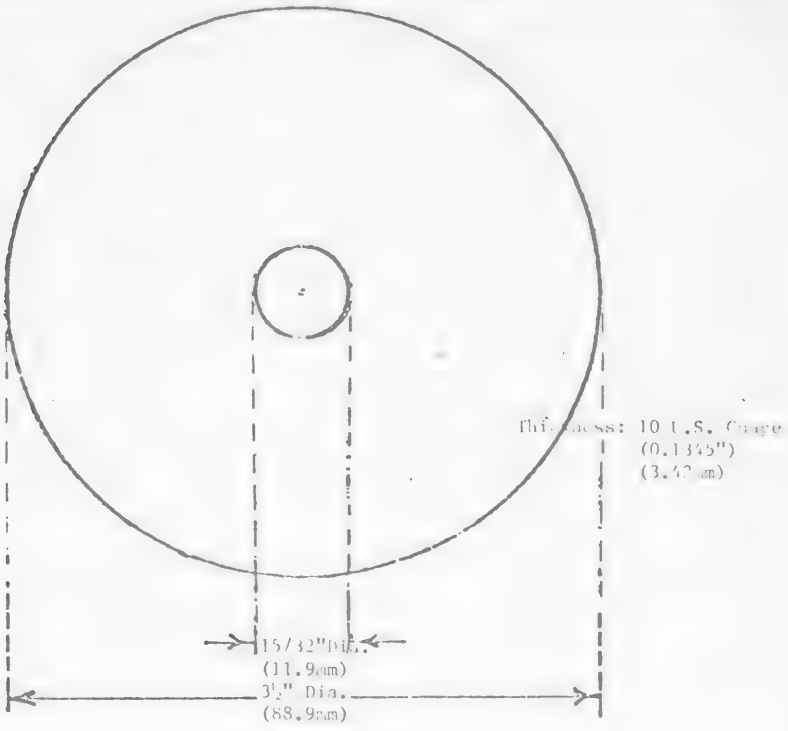
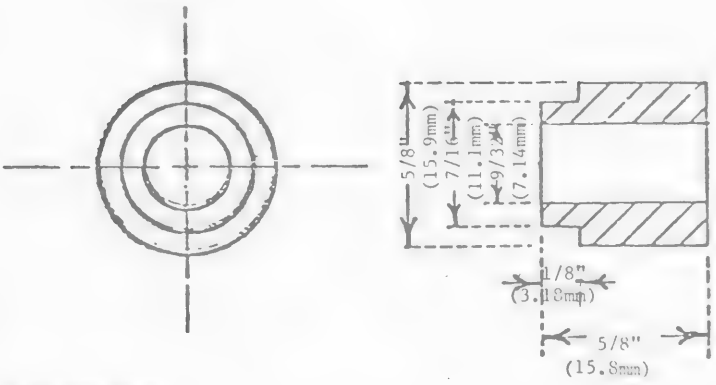


Figure 1. Test Specimen for Corrosion Test

Figure 2.



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All coupons or test specimens shall be prepared in accordance with Method G 1. The coupons shall be degreased in an organic solvent, such as acetone, hexane, methanol, or a combination of these. Hot alkalis and chlorinated solvents are not to be used since they may attack some metals. Abrasive cleaners shall not be used and brushing shall be kept to a minimum to prevent work hardening of the surface. Cleaning of the coupon shall be followed by a water rinsing, drying by an air jet, and storing in an oven maintained at 110° F (43° C) until ready to be used. Handling of the clean coupon must be kept to an absolute minimum, and no towel drying used, to avoid the introduction of grease, lint or other foreign materials on the coupon.

(ii) Apparatus. (A) 1 Analytic balance, capable of weighing test coupons to 0.2 mg. (B) 1 Specimen corrosion box. A plastic tray with inside dimensions of no less than 12 by 7¾ by 5 inches (304.8 by 197 by 127 mm) shall all have three 5/32 inch holes drilled in the 12 inch (304.8 mm) long side, 2½ inch (63 mm) above the bottom of the tray and at the center line of the 12 inch (304.8 mm) side, and 4 inches (100 mm) on each side of the center line as shown in Fig. 3.

(C) 6¼ inch PVC or other suitable plastic threaded rod with plastic nuts.

(D) Plastic spacers, fabricated from ⅝ inch (15.9 mm) diameter PVC or other plastic rods, with a 9/32 inch (7.14 mm) diameter hole drilled through the center, which should have one edge machined to a 7/16 inch (11.1 mm) diameter for a depth of ⅛ inch. (3.18 mm) on one end of the rod, as shown in Figure 2. The test coupon is to be slid over the machine end, and the adjacent spacer shall secure the test coupon on the ¼ inch (6.4 mm) diameter threaded plastic rod.

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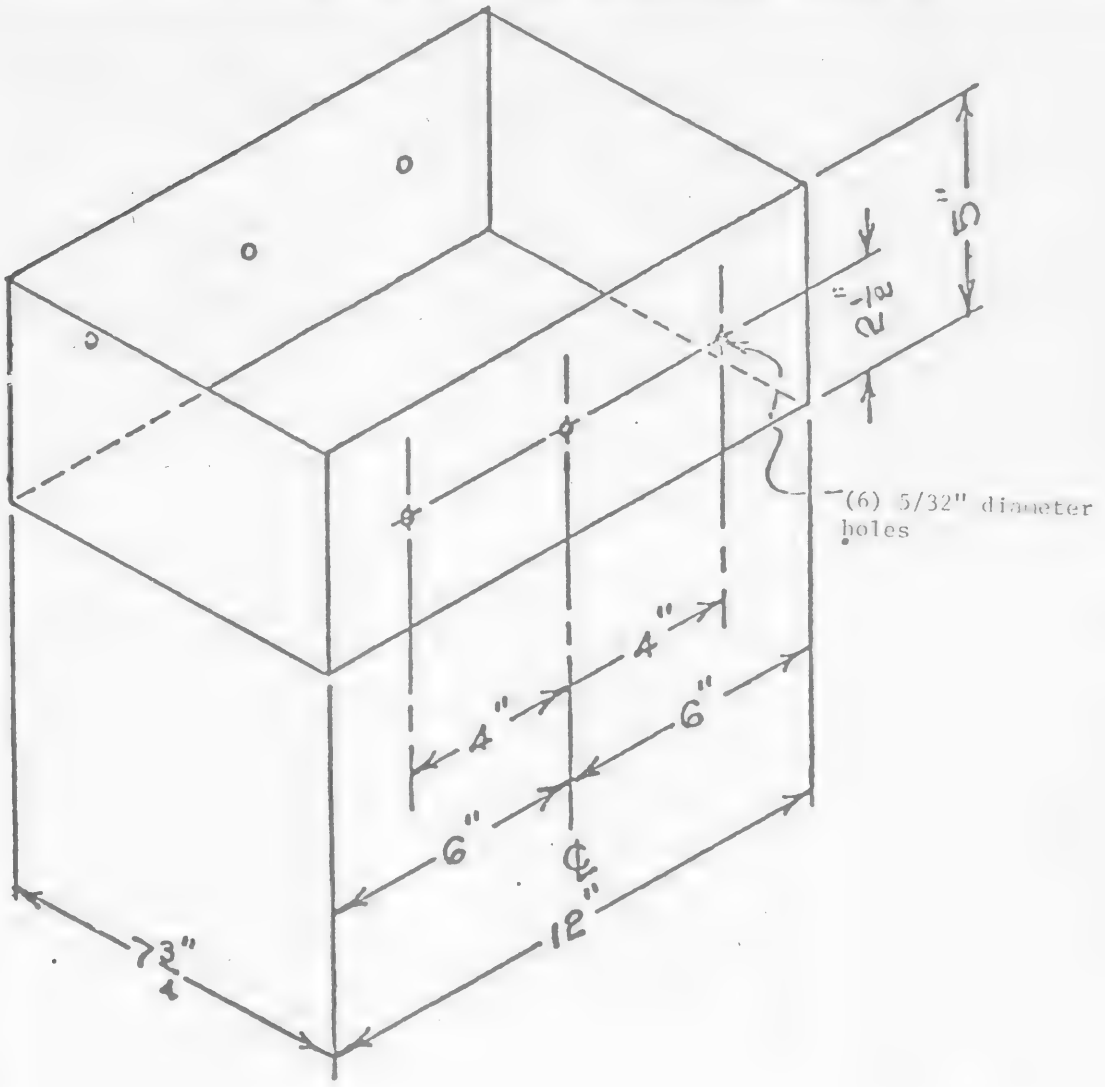

Figure 3 Specimen Corrosion Box

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(iii) Remove the test coupons from oven maintaining 110° F (43° C) and allow to cool to room temperature. Weigh test coupon on the analytic balance to the nearest 0.2 mg and position on plastic spacer on the ¼ inch (6.4 mm) diameter plastic rod. Place similar coupons adjacent to each other and place a plastic spacer between each coupon. Place two plastic spacers between dissimilar materials and continue mounting test coupons on the ¼ inch (6.4 mm) diameter plastic rod.

(iv) After all coupons are mounted on plastic rod, add special spacer measured to hold all the spacers tightly when fitted into the plastic tray. While holding the coupon firmly on the rod by the spacer, slide the ¼ inch (6.4 mm) plastic rod through one hole in the tray, and then slip the rod down moving it out in the hole just positioned into, and slide through second hole in the tray. Place plastic nuts on both ends of rod to hold the coupons rigidly in the plastic sample tray.

(v) The tray shall be fitted with the three holes, so that two additional plastic rods with three sets of samples can be installed in the tray for additional testing to increase the reliability of the results. A minimum of two test trays shall be prepared in this matter. Foam each test tray to the top edge and allow to cure at room temperature of 73 ± 3°F (23 ± 2°C) and 50% ± 5% relative humidity. One corrosion tray is to have the test coupon removed after 28 days following initial foaming, and the second test tray shall have the test coupon removed after 56 days following initial foaming (an additional 28 days from the first control tray). The samples are removed by cutting the foam parallel to the plastic rod and 2 inches (50 mm) from the rod for the full width and depth of the tray. The plastic nuts shall be removed from the threaded plastic rod, and the rod with the test coupon and block of foam shall be removed from the tray as a unit. The foam shall be cut away from around each test coupon and loose particles removed with an air jet.

Remove each coupon from the threaded rod, and remove excess loose foam by light brushing or an additional air jet treatment. Weigh each coupon on the analytic balance to the nearest 0.2 mg and compare weight with initial weight of sample. Any weight increase shall be reported as weight of corrosion products. Clean test coupons by Method G 1 for the respective materials and weigh each coupon after cleaning. Determine the weight loss of sample from repeated weighing after each cleaning and determine weight loss from corrosion by Method G 1–A2. Any pitting attack shall be evaluated by Method G 46 and be reported as a ratio of deepest metal penetration to average metal penetration (pitting factor).

(vi) Calculations. The corrosion rates, expressed as mils penetration per year (mpy) or mm per year (mmpy) can be calculated by the following equation:

$$\text{Corrosion Rate} = \frac{K \times W}{A \times T \times D}$$

where:

K = A constant to correct for different units.
T = Time of exposure in hours to the nearest 0.1 hours.
A = Total surface area in in^2 to the nearest 0.01 in^2 or cm^2 to the nearest 0.01 $cm.^2$
W = Weight loss in mg to the nearest 0.2 mg.
D = Density in g/cm^3 (see Appendix A 1, Method G 1.)

Constant K

Corrosion Rate Units Desired	Area in in^2	Area in cm^2
mils per year (mpy)	534.75	3450
mm per year (mmpy)	13.57	87.6

The Area = $\frac{\pi}{4}$ (D^2 - D_h^2)

where:

D = Diameter of the test coupon (3½ inches or 89 mm)
D_h = Diameter of the hole ($1^{5}/_{32}$-inches or 12 mm)

(vii) Reporting Corrosion Rates. The pitting factor shall be reported for both the initial corrosion rate and the average corrosion rate as determined from both test coupons. The acutal reported values will be corrosion rate of the 56-day sample minus the corrosion rate of the 28-day sample. These reported values shall be compared with the limiting values given in 6.7.

(5) *Test method for wet density.* Weigh to the nearest gram a measured quantity of freshly foamed material in a tared container within five minutes after formation. Calculate wet density using the formula:

$$\text{Density } (kg/m^3) = 1{,}000 \times \frac{\text{Weight of Container (g)} - \text{Tare (g)}}{\text{Volume } (cm^3)}$$

(6) *Test method for water absorption.* Cut three cubes, each 180×180×90 mm (7.1×7.1×3.5 in.) from a block of foam, and allow them to stand at room temperature until 3 successive daily weighings vary no more than 1 percent. Accurately weigh each cube and place them singly on a distilled water surface. The surface in contact with the water shall be that obtained from foaming. After seven days at 23 ± 2° C. (73 ± 4° F.) and 50 ± 5 percent R.H., remove the cubes and accurately weigh them. Calculate the percentage of water absorption on a volume basis.

(7) *Test method for free formaldehyde content of resin.* Prepare a standard sulfite solution as follows: Dissolve, without heating, approximately 250 g Na_2SO_3 (sodium sulfite) in about 200 ml distilled water. Dilute to one litre. Adjust the pH of the sulfite solution to 8.9 with H_2SO_4, and NaOH solutions. The solution is stable only for a short period of time and it must be used immediately after adjustment of the pH. Place 20 ml distilled water in an Erlenmeyer flask. Accurately weigh approximately 2 g resin solution (ready for foaming) and add it to the flask. Stir the mixture well, add approximately 10 g crushed ice and mix thoroughly. Add

50.0 ml of the standard sulfite solution and titrate immediately with 0.01 N H_2SO_4 to pH 8.9. Perform the procedure in duplicate and run a blank. Calculate the percentage formaldehyde content to the resin as follows:

Percent formaldehyde = 3(A–B)D/C

Where:

A = mL of 0.01 N H_2SO_4 for the specimen
B = mL of 0.0] N H_2SO_4 for the blank
C = mass of resin solution, g
D = normality of the H_2SO_4 solution.

(8) *Test method for free formaldehyde content of fresh urea-formaldehyde foam.* This test shall be conducted on three foam specimens taken from the same slab of foam and one blank. These specimens shall be collected fifteen minutes after foaming. Produce a cone of foam and allow it to set at ambient temperature and relative humidity for 15 minutes, but not longer than 1 hour. Each of the procedures described below must be conducted in this time frame. Slice off the exterior surfaces and cut three samples measuring about 50×50×75 mm (2×2×3 in.) each weighing approximately 6 to 10 grams.

(i) The following laboratory equipment and chemicals are required:

(A) 50-ml burette

(B) Four 1000 ml beakers

(C) pH meter

(D) Magnetic stir and stir bar

(E) Blender

(F) Balance (capable of 0.01 grams)

(G) A solution of 50% reagent grade methanol and 50% distilled water

(H) 0.05 N acid (standardized HCl or H_2SO_4)

(I) 0.1 N sodium hydroxide

(J) 1 M acid (HCl or H_2SO_4)

(K) 1 M sodium sulfite

(ii) Prepare a 1 M sodium sulfite solution by dissolving without heating approximately 252 grams $Na_2SO_3 \times 7$ H_2O or 126 grams of Na_2SO_3 in about 400 mL of formaldehyde-free distilled or deionized water. Dilute to 1,000 mL. Adjust the pH of the sulfite solution to 9.0 with 1 M acid and 0.1 N sodium hydroxide. This solution then is stable for 24 hours at 20–25°C (68–77°F) or five days of 0–7°C (32–44.6°F).

(iii) Cool approximately 400 ml of water/methanol solution to about 0°C. Weigh a foam specimen and place it in the blender with about 200 ml of the cold water/methanol solution. Blend at a medium speed until the foam sample is completely disintegrated (5–10 seconds).

(iv) Pour the blended mixture into a beaker. Rinse the blender with the remaining ice water in three portions, adding the rinses to the beaker.

(v) Immediately adjust the pH of the mixture in the beaker to 9.0 with 0.1 N NAOH while stirring vigorously.*

(vi) From a graduated cylinder, add 50 ml of 1 M sodium sulfite (adjusted to pH 9.0).

(vii) Titrate immediately to pH 9.0 with 0.05 N acid. No more than 30 seconds should elapse from the addition of the sulfite solution to the end point of the titration.

(viii) Run a blank determination using the same amounts of water and sodium sulfite solution but without the sample.

(ix) The percentage of free formaldehyde contained in the foam shall be determined by the following equation.

$$\text{Percentage formaldehyde} = \frac{3.003\ (A - B)\ D}{C}$$

Where:

A = ml of 0.05 N acid titrate added to the sample
B = ml of 0.05 N acid added to the blank
C = weight of foam in grams
D = normality of the acid solution

Report the mean of the three determinations. If the difference between the highest and the lowest values exceeds 0.1 percent, the test should be repeated on a fresh foam sample.

(9) *Test method for setting time.* A conical specimen with a bottom diameter of approximately 30 cm (12 in.) and a height of approximately 30 cm (12 in.) shall be made by foaming from a hose. Start a stopwatch immediately after the cone has been formed and immediately commence slicing the cone with a spatula. Record the time when the foam no longer slices as if it were whipped cream but shears off leaving a smooth surface. This time is the setting time.

(10) *Test method for volume resistivity of fresh foam.* Foam the specimen in a plastic box which is made of non-conductive plastic and so designed that it may be opened for easy cleaning. Provide slits in the box to accommodate the brass electrodes forming a 90 mm (3.5 in.) cube of foam when they are inserted into the box. The box shall be equipped with grooves, about 2 mm (0.08 in.) in depth on the interior between the slits, to act as guides for the electrodes. Insert the electrodes into the slits, through the foam and through the other slits. The bevelled edge of the electrodes shall face outwards during insertion so that the foam specimen is not compressed. Then determine the volume resistivity of the foam in accordance with ASTM D 257 using a potential difference of 110V. The time between foaming the specimen and taking the instrument reading shall not exceed 30 seconds.

*The specimen must be stirred using the magnetic stirrer during the titration procedure to prevent the formation of a top layer of foam particles. Unless it is broken up, this covering of foam particles will obscure the end point and make a determination very difficult in the 30-second allowable titration time period.

(11) *Test method for water drainage.* Prepare a cavity approximately 2440 mm high, 400 mm wide and 90 mm deep (97.6 x 16 x 3.5 in.) from wood studs and plywood. Fill the cavity by foaming in place or trowelling. Leave the cavity in a vertical position for 24 hours, during which time the bottom and underside of the structure shall be examined for water. The cavity shall be built so that any free water from the foam can run out easily at the bottom. Caulks, sealants, and adhesives are not to be used in the construction of the cavity.

(12) *Test method for shrinkage.* Construct three boxes, approximately 480 x 480 x 90 mm (19 x 19 x 3.5 in.) from nominal 2 x 4 inch wood studs and exterior grade plywood. Fill these three boxes with U–F foam, cover them, and maintain for 28 days at 23 ± 2°C (73 ± 4°F) and 50 ± 5 Percent R.H. Then open the boxes and measure the linear shrinkage of the U–F foam in the two principal directions. Report the average of all six determinations as linear shrinkage. If fractures in the specimens occur, the data shall be discounted, and the test repeated.

(g) *Equipment.* (1) *Testing Requirements.* (i) The volume flows shall be consistent from the beginning to the end of continuous foaming operations of a quantity of 20 ± 5 gallons of both resin and foaming agent to within a tolerance of ± 5 percent of the standard set out in paragraph (g)(2)(i) of this section.

(ii) The ratio of flow between the liquid ingredients shall be consistent from beginning to end of continuous foaming of a quantity of 20 ± 5 gallons of both liquid ingredients to within a tolerance of ± 5 percent from manufacturer's prescribed ratio between the liquids when tested in accordance with the test method specified in paragraph (g)(2)(i).

Example. Assuming 20 gallons of foaming agent used and 20.5 gallons of dilute resin, the ratios would be 1 to 1.025 foaming agent to dilute resin, which is an acceptable ratio for a

product required to maintain a 1 to 1 ratio.

(iii) The wet density of the U–F foam shall be consistent from beginning to end of continuous foaming of a quantity of 20 ± 5 gallons of both liquid ingredients to within a tolerance of ± 5 percent of the manufactuer's test procedure. A minimum of three density tests must be taken over the 20 ± 5 gallons pumped of both liquids (shortly after start, middle, and just before the end).

(iv) Alarm shutdown mechanisms shall be tested per paragraph (g)(2)(iii). Equipment that fails the flow ratio per paragraph (g)(2)(i) but does not activate the alarm or shut-down mechanism, constitutes noncompliance to this standard. For each test per paragraph (g)(2)(i) that fails, an additional successful test must be run. A test failure is one that was interrupted because of alarm or shut-down mechanism being activated.

(v) The equipment shall be subject to a cyclic performance test to simulate typical wall filling conditions. Ten on-off cycles (30 ± 5 seconds on and 15 ± 5 seconds off) shall be run without causing out-of-tolerance flow ratios. The wet density of foam on the first cycle shall be within the manufacturer's specification and when compared with a wet density test after the last cycle, shall be within ± 5 percent of that from cycle one. Cleaning of the exit hose or other components in contact with mixed ingredients is allowed prior to final wet density test. The ratio of flow between the liquid ingredient shall be within a tolerance of ± 5 percent from the manufacturer's prescribed ratio between liquid when tested in accordance with the paragraph (g)(2)(iii) test method. The provisions of paragraph (g)(1)(iv) shall apply to this cyclic performance.

(2) *Equipment Testing Procedures.* (i) Measure the volumes of ingredients consumed while making U–F foam to an accuracy of ± 2.0 percent of full scale. A plastic pipe with a sight glass connected in a verticle position can be calibrated to serve as a graduated column. Set up and prime the liquid systems after connecting the graduated column. Make trial U–F foam to achieve the manufacturer's proper specification. Note the level of both liquid ingredients in the graduated columns prior to measurement during timed trials. On continuous pumping trials, a minimum of four sets of readings must be taken and spaced uniformly over the pumping period. The elapsed time between each reading must be determined to ± 2.0 percent. If the prescribed amounts of liquid are made into U–F foam and no automatic alarm or shutdown has occurred, collect the data as described below: .

(A) For each time interval, determine the volume pumped and the time; calculate the ratio of foaming agent to resin of each time interval.

(B) Calculate the overall ratio for the total test period.

(C) Calculate the gallons per minute flow rate for each time interval.

(D) Calculate the total volume pumped for foaming agent and resin at the completion of the test. The foam density at the completion of the test shall be determined per the manufacturer's prescribed method to specification.

(E) Verify that alarm or shut-down devices are working properly per paragraph (g)(2)(iii) since they were not activated during the test.

(ii) The cyclic testing shall measure the volumes of ingredients consumed while making U–F foam to an accuracy of ± 2.0 percent of full scale using graduated columns as described in paragraph (g)(2)(i) of this section. Perform the prescribed checks and note the liquid levels. Perform the prescribed cycle of operations per paragraph (g)(1)(v). Measure the total volume of ingredients used and determine the overall ratio.

3. 10 CFR Part 456 is amended by adding § 456.909 to read as follows:

§ 456.909 Interim standard practice for the installation of urea-formaldehyde foamed-in-place insulation.

(a) *Scope.* (1) This section presents an interim standard which applies to urea-formaldehyde foamed-in-place insulation of existing residential buildings. This material is approved for exterior sidewall application only, and is not approved for use in attics, above ceilings, under floors, in knee walls, in mobile homes, or in below-grade applications.

(2) This practice covers the installation process from pre-installation procedures through post-installation procedures. It does not cover the manufacturing of the material components, but it does cover the process of combining components to form foam and it also covers field quality control checks.

(3) This practice provides minimum requirements that will help to insure the installation of insulation in a safe and effective manner. It must be noted that actual conditions in existing buildings vary greatly and in some cases substantial additional care and precaution may have to be taken to assure effective and safe installation.

(4) This practice covers aspects of installation relating to the safety of persons and property, effectiveness, and durability of insulation in service, and prevention of related structural damage to the residence.

(b) *Definitions.* The definitions in § 456.810(b) apply to this section.

(c) *Significance.* (1) This practice recognizes that effectiveness, durability, prevention of related structural damage, and safety of insulation depends not only on the quality of the insulation materials, but also on their proper and workmanlike installation.

(2) Improper installation of U–F foam may reduce its thermal effectiveness, cause damage to the structure, and cause unsafe conditions.

(d) *Safety Precautions.* (1) Wear safety equipment to protect hands and eyes against acid contained in the chemicals.

(2) Avoid contact between the uncombined chemical components of U–F foam and building materials to prevent staining or corrosion.

(3) Follow label instructions regarding hazards related to the materials.

(4) Observe all safety rules provided by the installation equipment manufacturer. Properly set relief valves on pressurized liquid and air vessels and exercise proper use of electrical power tools.

(5) Keep all persons not involved in the installation a safe distance from work areas and installation equipment.

(6) Maintain proper ventilation on the job to prevent excessive exposure to formaldehyde gas.

(7) Follow the manufacturer's instructions for storage of U–F foam components and follow proper methods of disposal of old or unusable resin and foaming agent solutions.

(e) *Installer requirements.* (1) The installation of U–F foam may only be performed by insulation installers trained and certified by the material components manufacturer.

(2) Persons installing U–F foam must have a working knowledge of the applicable codes and regulations, tools, equipment, and methods necessary for the installation of thermal insulation materials. These persons are also required to have an understanding of the fundamentals of residential construction that affect the installation of insulation.

(f) *Equipment.* (1) Use only equipment which has been recommended by the manufacturer for use with the manufacturer's product.

(2) Ensure that hose lengths conform to the insulation manufacturer's requirements.

(3) Check the equipment for proper functioning and cleanliness before starting a job. Clean and maintain the equipment according to the equipment

manufacturer's instructions but at a minimum, at the following intervals:

(i) Before installing each new batch of U–F foam.

(ii) After every down time of at least 15 minutes.

(iii) At the conclusion of the installation process.

(g) *Foam Generation and Field Quality Control Checks.* (1) Follow the manufacturer's instructions for generating the foam.

(2) Do not use containers of resin or foaming agent after the shelf-life date specified on the container labels by the manufacturer.

(3) Use only materials supplied by the same insulation manufacturer and, where that manufacturer supplies more than one product, ensure that the individual components to be combined are compatible.

(4) Handle all insulation materials in accordance with the manufacturer's instructions. Keep powdered products dry and free of extraneous materials.

(5) Perform all field quality control checks prescribed by the manufacturer. At a minimum, perform the following checks at the specified frequencies:

(i) Setting time (gel time). Test in accordance with Standard for Urea-Formaldehyde Foamed-in-Place Insulation [see § 456.810(e)(9)]. Test before installation each day on each job for each material batch. Check setting time after any change in chemical concentration. Setting time must conform with the manfacturer's recommendations for the type of structure and procedure being used but shall not exceed 60 seconds nor be less than 10 seconds.

(ii) Wet density. Test in accordance with Standard for Urea-Formaldehyde Foamed-in-Place Insulation [see § 456.810(e)(5)], and ensure that wet density is within manufacturer's specifications. The wet density shall be measured five minutes after foaming. Check the wet density on each new batch of materials, on each new job, and after each down time of at least 45 minutes. Whenever changing from an empty to full container, the density must be retested. The density must also be repetitively tested throughout the foam-making period at a frequency depending on the setting time: for a set time of 20 seconds, check the density at intervals of no more than twenty (20) minutes; for a 60 second set time, check the density at intervals of no more than sixty (60) minutes.

(iii) Ratio of resin to foaming agent. Determine the ratio of resin to foaming agent for each batch of materials on each day on each job by measuring the number of gallons of each liquid used.

(iv) Temperature of liquids. The temperature of the liquids shall be within the acceptable range specified by the manufacturer.

(v) Specific gravity of dilute resin. Check the specific gravity of each batch of dilute resin with a hydrometer to insure that the specific gravity is within the upper and lower limits specified by the manufacturer. Do not use materials whose specific gravity is out of range.

(vi) Water temperature and hardness. When reconstituting powdered U–F foam components ensure that the water temperature and hardness are within the acceptable ranges specified by the manufacturer. Maintain a reconstitution record for each batch of material prepared.

(vii) Ensure that the foam is characterized by uniform cell distribution.

(6) Maintain a record of the results of all field quality control checks and of other pertinent information required by the maufacturer, including, but not limited to:

(i) Date of application,

(ii) Outdoor ambient air temperature,

(iii) Material lot number(s),

(iv) Expiration date(s),

(v) Equipment identification number,

(h) *Pre-Installation Procedures.* (1) Inspect and identify areas where a previous moisture problem has caused paint peeling, warpage, stain, visible fungus growth, rotting, or other structural damage. Do not install insulation in such areas until the resident has been notified and these conditions have been corrected and their source(s) eliminated. If the resident, after being informed of the moisture condition and the effects of installing insulation in such areas, elects to proceed with the installation, the resident must so state in writing on the contract.

(2) Block all openings in sidewalls through which the insulation material may escape. Seal all wall cavities which open into an attic, basement, or crawl space prior to installing insulation.

(3) For buildings located in Zone I of Firgure 1, provide a vapor barrier on the interior surface of all walls to be insulated in bathrooms, and unvented kitchens and laundry areas. Caulk or seal all major cracks on the interior face of exterior walls of these rooms including joints between the floor and wall (except where impractical because of carpeting), between wall and ceiling, at joints around window frames, and around wall penetrations for electrical services (outlets and switches), plumbing stacks, and heating and air-conditioning ducts.

Note 1.—It is recommended that a vapor barrier and caulking, such as described in this section, also be provided on all walls to be insulated in bathrooms and unvented kitchens and laundry areas in buildings in Zone II of Figure 1.

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Figure 1. Condensation Zones in the United States

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Note 2.—The above requirements for moisture control are minimum requirements needed to prevent long-term moisture damage. Homes which are characterized by one or more of the following conditions are more likely to experience excessive moisture accumulation which can be corrected by application of a vapor barrier and caulking as described above and/or additional venting of the wall cavity from the exterior or by additional ventilation of the occupied space:

a. Homes with an area of less than 800 sq. ft.

b. Homes with less than 250 sq. ft. per occupant.

c. Homes with tight wall and ceiling construction and weatherstripped windows and doors.

d. Electrically heated homes or homes with a heating system which uses outside combustion air.

A relative humidity indicator may be installed to monitor the humidity level and determine when excessive moisture accumulation is likely to occur.

(4) Examine the material on the indoor side of exterior wall contructions. Ensure that it is gypsum board 12.5 mm (0.5 in) thick or an equivalent fire barrier when tested in accordance with ASTM E 119–76.

Note 3.—Some U–F foam manufacturers do not recommend applying foam directly against certain types of wall coverings. Some wall coverings that should be approached with caution are: knotty pine tongue and groove, wain-scoting, colonial inset board paneling, printed wood paneling, and particle board. Check with the manufacturer prior to installation.

(5) Determine if the structure has dissimilar metals with large surface areas exposed in the same cavity. (Since the foam is wet with mild acidity, rapid electro-chemical corrosion can take place.) An example condition that might lead to electrolytic corrosion following U–F foam insulation installation is an exterior wall cavity enclosing both copper plumbing lines and aluminum electric wiring. Contact the manufacturer to obtain assistance with such application, and follow the manufacturer's recommendations.

(6) Inspect window frames. Identify any windows which contain internal mechanisms such as springs, counterbalance weights, friction strips, etc. in their frames. Follow the manufacturer's specific installation procedures for foaming these areas.

(7) Provide the customer with a statement identifying the effective thermal resistivity of the material to be installed, as determined by the test method in the standard for Urea-Formaldehyde Foamed-in-place Insulation, and a statement containing the safety information contained in § 456.810(D)(11)(ii).

(i) *Installation Procedures.* (1) General.

(i) Do not install insulation unless the pre-installation procedures have been carried out and any defects which were identified have been corrected and their causes eliminated.

(ii) Do not install insulation unless all field quality control and equipment checks required to be performed prior to installation have been completed. Conduct tests as required during the installation.

(iii) Operate all installation equipment in accordance with the equipment manufacturer's instructions.

(iv) Structural damage can be caused by excessive pressure during installation or can result from installing U–F foam insulation in constructions too weak to withstand normal pressures. Assure that installation does not cause the structural failure of the wall construction or its components. Specifically, the following conditions must not result from the installation:

(A) Separation of finish materials from studs

(B) Cracking of materials or opening of joints between boards

(C) Deflection of more than 1/200 of the stud spacing.

(v) Install insulation only in exterior walls between conditioned and unconditioned spaces.

(vi) Open all entry holes with a technique that permits refinishing with little or no change in appearance.

(vii) Do not install insulation in wall cavities which themselves are air ducts for heating, ventilation, and/or cooling systems.

(viii) Do not install insulation when the atmospheric relative humidity, or outdoor ambient temperature, or cavity temperature is not within the acceptable range specified by the manufacturer.

(ix) Install insulation only in cavities which will preclude contact by the insulation with the ground or other sources of water.

(x) U–F foam is a combustible material. Install U–F foam so as to meet the applicable requirements listed below:

(A) If a wall cavity contains recessed lighting fixtures or other heat producing devices, either provide a three inch minimum clearance around the recessed lighting fixtures (including wiring compartments and ballasts) and other heat producing devices not covered in paragraph (B) or do not install U–F foam in the cavity containing such heat producing device(s). Do not cover these devices so as to entrap heat or prevent the free circulation of air, unless they are approved for such purpose.

(B) Provide the minimum clearances around gas fired appliances specified in NFPA–54, the National Fuel Gas Code. Around oil-fired appliances, provide the minimum clearances specified in NFPA–31, Standard for the Installation of Oil Burning Equipment. Around masonry chimneys or masonry enclosing a flue, provide a minimum two-inch clearance from the outside face of the masonry. Around vents, chimney and vent connectors and chimneys other than masonry chimneys, provide the minimum clearances specified in NFPA/211, Standard for Chimneys, Fireplaces, and Vents.

(xi) Remove any foam which is inadvertently sprayed on glass or exterior siding before drying occurs.

(xii) Setting time must be sufficient in duration to permit complete filling of the cavity before setting begins. Setting time cannot be too fast.

(2) *Frame Walls.* Insulate frame construction walls (including masonry veneer construction) by one of the following two procedures:

(i) Method A. Do not foam cavities in excess of 10 ft. in height by this method.

(A) Make an entry hole (fill port) between half and three quarters of the way up the wall. Make the fill port at least ½" larger in diameter than the outside diameter of the hose to allow air relief and maneuvering of the hose.

(B) Probe the cavity for blockages and make additional fill ports as necessary to ensure complete filling of the cavity. For a typical layout of fill ports, see Figure 2.

(C) Insert the applicating hose into the cavity within approximately 2 to 4 inches from the bottom (see Figure 3, Position "A").

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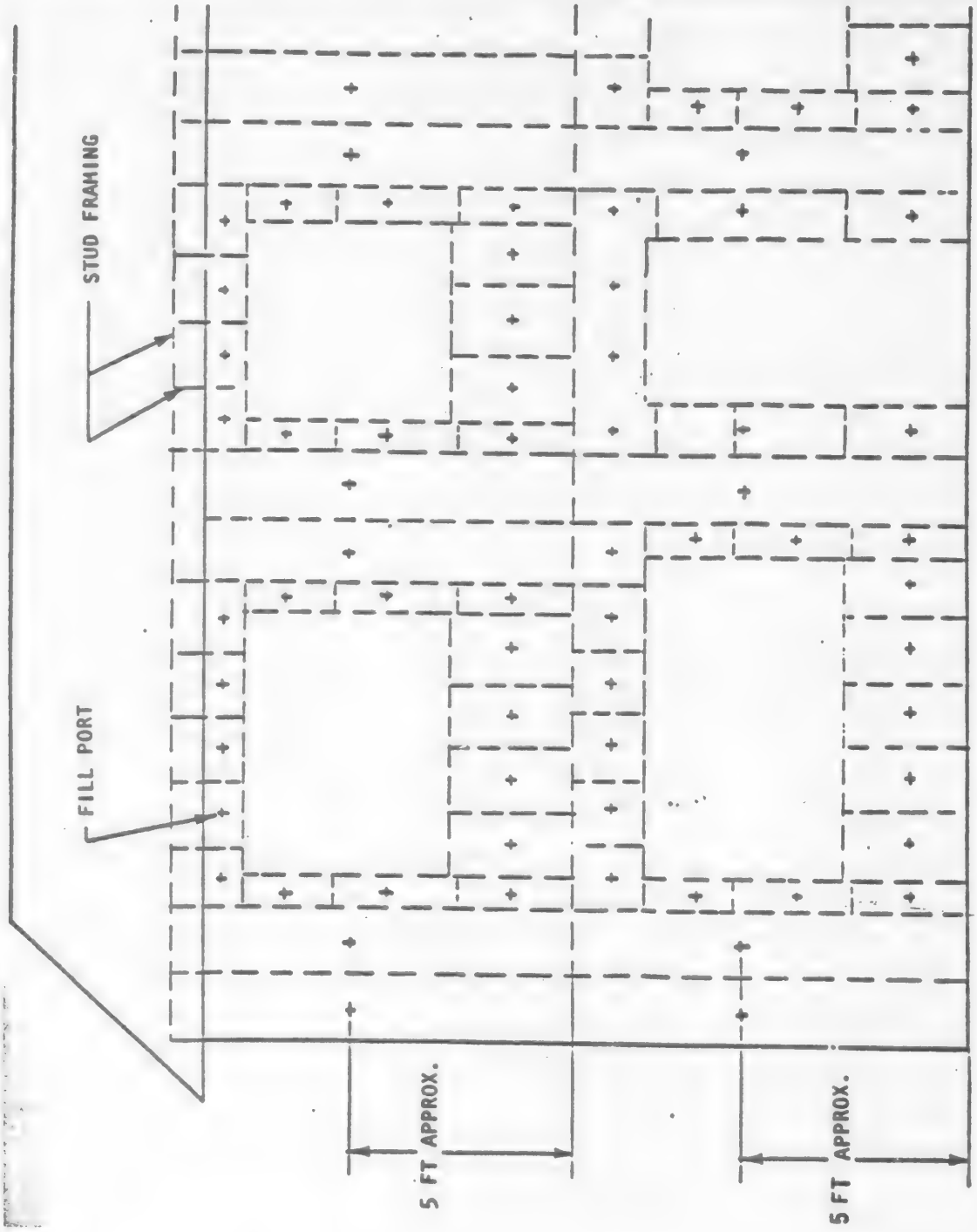
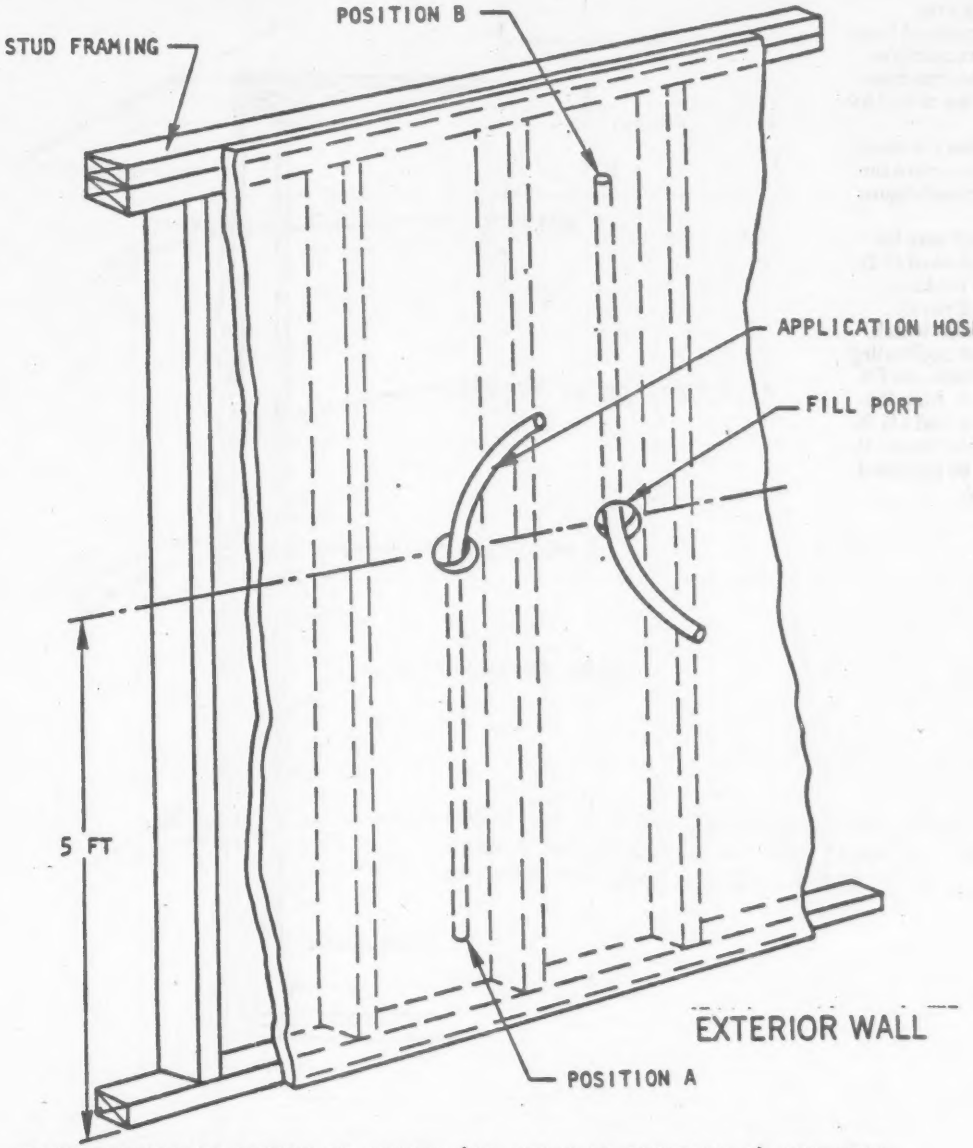


Figure 2. Typical Layout of Fill Ports



START FOAMING AT BOTTOM OF CAVITY (AS SHOWN IN POSITION A) AND KEEP WITHDRAWING HOSE SLOWLY AS CAVITY FILLS UP. WHEN FOAM STARTS FLOWING OUT OF THE FILL PORT, REVERSE THE HOSE AS SHOWN IN POSITION B AND PROCEED AS BEFORE. CHECK CAVITIES FOR OBSTRUCTIONS (I.E., FIRE STOPS, BLOCKAGES, ETC.) AND DRILL ADDITIONAL FILL PORTS IF NECESSARY.

Figure 3. Insulating Closed Cavities
Method A

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(D) Retrieve the hose at a rate approximately equal to the rate of foam dispensation unless the manufacturer specifically recommends that the hose remain at the extremity of the cavity for the total filling time.

(E) When the foam reaches the level of the fill port repeat the procedure for the upper part of the cavity (see Figure 3, Position "B").

(ii) Method B. This method may be used to foam cavities in excess of 10 ft. in height as well as shorter cavities.

(A) For each unobstructed cavity, make at least three entry holes which correspond to the size of the applicating hose (or adaptor, if used). Place the fill ports at approximately 1½ ft. from the bottom, 4 ft. from the bottom and 1½ ft. from the top of the cavity (see Figure 4). An air relief hole may also be provided at the very top of the cavity.

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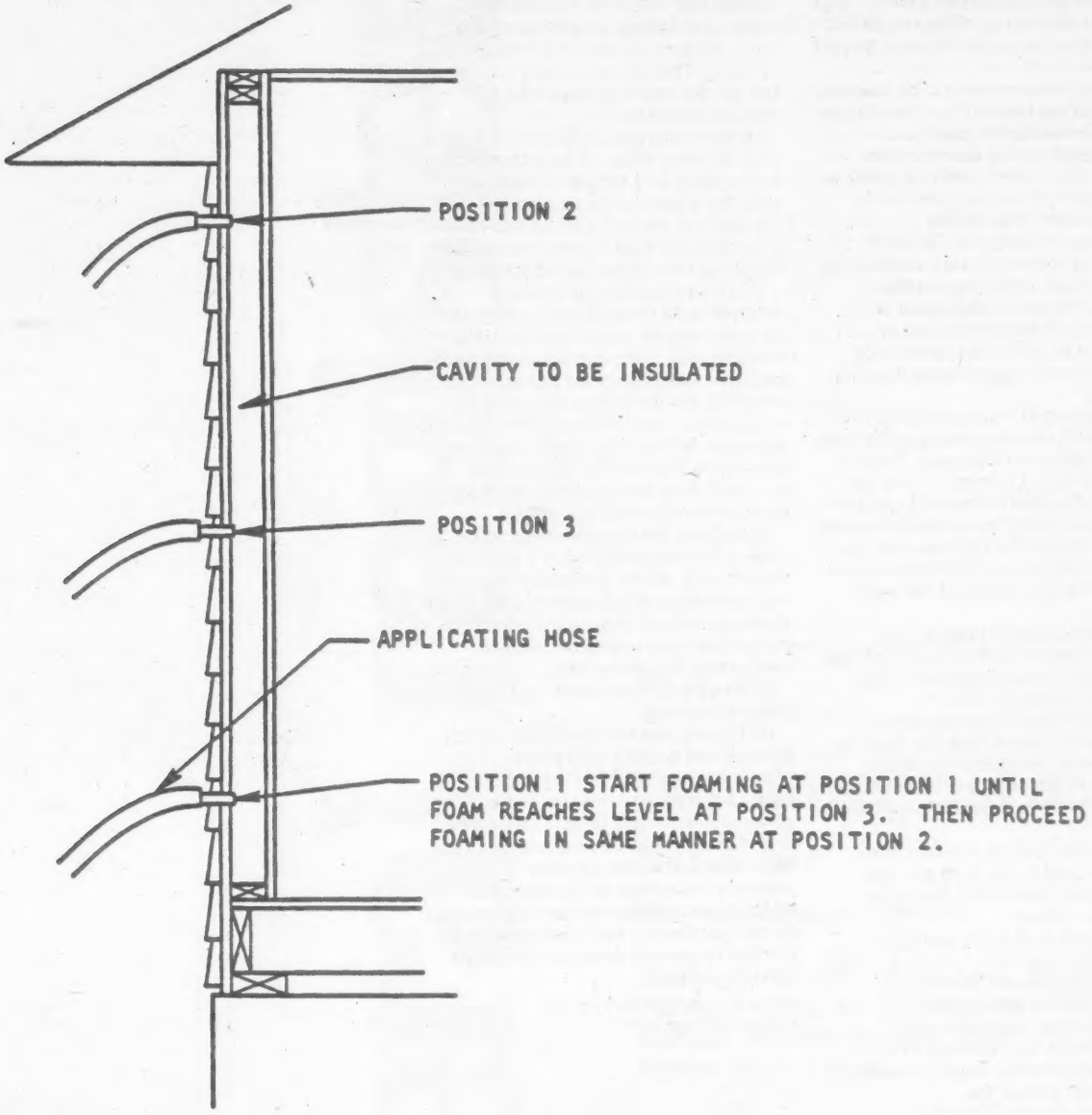
POSITION 2
CAVITY TO BE INSULATED
POSITION 3
APPLICATING HOSE
POSITION 1 START FOAMING AT POSITION 1 UNTIL FOAM REACHES LEVEL AT POSITION 3. THEN PROCEED FOAMING IN SAME MANNER AT POSITION 2.

Figure 4. Insulating Closed Cavities Method B

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(B) Place the applicating hose up to or just inside the bottom fill port and dispense the foam until the next fill port level is reached.

(C) Repeat this procedure by foaming through the top level fill port until foam reaches the center fill port.

(3) *Masonry cavity construction* (concrete block, brick on brick, brick on block). (i) Do not use this method to foam brick veneer on frame construction. Attempts to fill brick veneer construction by this method may cause buckling, breaking, or other damage to the walls. Brick veneer construction should be foamed in accordance with the instructions for frame construction in paragraphs (i)(2)(i) and (ii).

(ii) The internal void area (cavity) in masonry wall constructions usually runs the entire distance of the wall. Provide holes at three foot intervals along the horizontal distance of the wall and two foot intervals along the vertical distance of the wall. Begin the bottom-most row of holes at a distance of between one to two feet from the bottom of the wall cavity.

(iii) Begin foaming at one of the bottom corners of the wall and continue foaming until foam is detected at the horizontally adjacent hole.

(iv) Ensure that the setting time is longer than the time it took the foam to travel between the horizontal holes.

(v) Move to the adjacent horizontal hole and repeat the procedure specified above.

(vi) After the bottom row has been foamed, proceed to the next row and repeat the procedure until the entire wall has been filled.

(4) *Buildings with metal exterior surfaces.* Buildings with a metal exterior surface require special installation techniques. U–F foam should not be installed in these buildings unless adequate means are provided to allow for moisture and other vapor to escape to the outside. Follow the manufacturer's instructions for application to these types of structures.

(5) *Window-Door Frames.* (i) Do not apply U–F foam to the frames until after the walls have been insulated.

(ii) Drill entry holes which correspond to the size of the applicating hose (or adaptor, if used) into the void areas around the frames. Drill holes into the fascia of the frame wherever possible.

(iii) Foam each entry hole until foam appears at the adjacent hole or until foam emerges from cracks in and around the moldings.

(iv) If the window has any moving parts within the space to be insulated, work the mechanism of the closure. For a fast setting time (10 seconds) work the mechanism within 15 minutes of filling. For a slow setting time (60 seconds) work the mechanism within 30 minutes of filling. This procedure will ensure that the interior mechanisms of the unit remain operative.

(j) *Post-installation procedures.* (1) Seal all entry holes on the exterior of the wall system in a manner compatible with the original materials and appearance. Seal all entry holes on the interior of the wall system immediately following the completion of foaming.

(2) Determine if many coats of exterior paint or caulking have created an impermeable vapor barrier on the exterior wall. Take corrective measures, such as loosening up the siding, removing caulking between wood laps, or installing vents/diffusers, to eliminate the vapor barrier and allow drying to take place. Ensure that the venting provided does not result in rain water leakage into the wall system.

(3) Inspect the interior of electrical wall outlet boxes and other electrical devices and, where necessary, remove any insulation which entered during the foaming process. Ensure that electrical power has been turned off prior to conducting this procedure.

(4) Ensure that windows and doors operate properly.

(5) Ensure that any insulation which has come in contact with glass, aluminum, or vinyl building components or has otherwise permeated the interior of the residence has been cleaned off.

(6) Offer the customer a sample of the foam installed at the customer's premises, at no cost to the customer, which is approximately the size required for the dry density test, packaged in a manner to prevent deterioration for at least three years.

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